Knowledge.

With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News.

A Monthly Record of Science.

Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

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ON HAIRS AND HAIR-PIGMENTS.

By H. ONSLOW.

THE origin of the pigments in the hair of men and animals is a subject that has already received much attention, and there exists a wide but scattered literature concerning it.

In spite of the considerable amount of labour that has been expended, the few conclusions arrived at do not seem to rest on a very firm experimental basis. But the attention that has been devoted to Mendelian analysis has given a fresh motive for the elucidation of this problem, and it has acted as a stimulus to further research.

The coat colours of animals form very distinct characters, and for some years it has been largely the custom to use these characters in Mendelian analysis, since by their means the material to be analysed can easily be placed in suitable categories. It is on account of this that further knowledge has been sought with regard to the nature and origin of the pigments underlying such coat colours; for the advantage that the science of genetics would gain, if it were able to express hypothetical pairs of allelomorphic characters in terms of another science, such as chemistry, is too obvious to need further comment. As a matter of fact, this has already, to some extent, been accomplished with regard to the pigments of flowers, though not yet to animal pigments.

Although the colours of animals are very distinct to the superficial glance, yet, under chemical and microscopical investigation, the pigments themselves do not seem to differ so widely; the colours tend to shade into one another, and the nature of the chromogens and the enzymes, which give rise to the pigments, is practically unknown.

STRUCTURE OF THE HAIR.

The structure of the hair is of special importance, for it controls to a considerable degree the macroscopical appearance of the hair, though this has not hitherto been clearly shown to be the case.

A typical hair-shaft is composed of three parts, the medulla, the cortex, and the cuticle. The medulla does not occur in all hairs, but when present consists of a single or multiple column of oval-shaped cells (see Figure 140, C and D), generally surrounded by, but sometimes filled with, air. These cells, containing pigment granules, may be seen in Figures 140 and 141. Next to the medulla —or, in its absence, occupying the entire shaft—is the cortex, composed of a fibrous substance which is resolvable into very long, pointed cells: these may again be reduced to minute fibrils by the continued action of a hot solution of ammonia under pressure. These fibrils do not, as has been supposed, serve to bind the horn-cells together, but they actually compose the body substance of the cells themselves, and the pigment granules frequently lie within them in single rows. Figure 140, A, shows

these rows of granules in the periphery of the hair.

Without the cortex is the cuticle, a layer of flat imbricated cells all pointing upwards, which cover the entire cortex like the scales of a fish. The interstices between the cells of the medulla, and sometimes of the cortex, are at first filled with a liquid, which often dries up, so that air can penetrate, and form a regular pattern or network of canals between the cells. This air may be seen between some of the cells of the big hair in Figure 142. Sometimes the cells themselves are filled with air, so that they swell out and look like small air-bubbles; but it is most usual to find the air present intercellularly.

The air-content or vacuoles show, in many hairs, so regular and homogeneous a pattern, that it is hard to believe that they are due simply to a haphazard shrinkage of the cells, and have no structural signification.

COLOUR OF THE HAIR.

The colour of human hair depends upon the colour and form of the pigment (*i.e.*, whether it is diffused, or deposited in granules) and upon the vacuoles. These vacuoles appear black by transmitted light on account of their optical properties, but by reflected light they become brilliant white points (see Figures 144 and 145). In light and sandy hair the pigment is chiefly diffused, and of a reddish-yellow colour, but in darker hair the pigment is present as dark brown or black granules. In the hair of albinos, however, of both fair and dark races, as well as in that of certain red-haired people, there occur practically no granules whatever, but only diffused pigment. When stained, human hair that has gone white with age shows no internal structure, but only a few irregular vacuoles, and, unlike white rabbit hair, becomes a pale colour throughout, with no pigment bodies whatever.

HAIR OF ANIMALS.

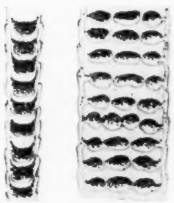
Among animals also the pigments and air-content are the chief factors that determine the colour. But there are so many different types of hair among the vertebrates that this description must necessarily be confined to those domesticated animals which have been mostly used in Mendelian analysis, namely, rats, mice, rabbits, and guinea-pigs. The hairs of these animals resemble each other very closely, since they all have a large intercellular air-content; and the three pigments, black, chocolate, and yellow, are apparently the same in the four species. The guinea-pig presents the greatest difference, since the red or yellow type possesses a certain amount of reddish-yellow pigment diffused throughout the medulla and the cortex, and further its hair shows a very perfect reticular system of air-canals, unlike the more vacuolated appearance of mouse and rabbit hairs.

The colours which have been most studied among these animals are black, chocolate, and yellow, caused respectively by black, chocolate, and yellow pigment, and also the dilute types of these colours, namely, blue, fawn, and cream, which are structural modifications of the intense colours. These dilute colours, as they are called, have been considered to be due only to a greater diffusion and a smaller number of the pigment granules than occur in the intense colours. As a matter of fact, this is not a full statement of the facts. A number of careful observations have shown that the intense colours contain only about seven per cent. more granule groups in a given length than the dilute colours, and the size of the granule groups is only seven per cent. larger in the former than in the latter (see Figures 140 and 141), while the size of the granules remains the same. It is true, however, that the pigment granules are not deposited so thickly in the light hairs, and that many of the darker hairs contain granules in the periphery as well as in the medulla (see Figure 140, A). In addition to this, the air-content of the hair plays a very considerable part. Looked at by reflected light (see Figures 144 and 145), the vacuoles appear larger and more conspicuous in the dilute colours, since they are less obscured by the granules. In the intense colours the granules not only tend to hide the vacuoles, but these are also often so distributed throughout the cortex, and between the granules groups, that they absorb the light before it is reflected by the vacuoles, so that the hair appears black or chocolate, instead of blue or silver-fawn, as it would do if more light were reflected.

Within the cells of the medulla and between each vacuole lie the granule groups, which are, on the average, 72μ broad and 112μ long, composed of. oval-shaped granules 1·2μ broad and 1·7μ long. The granules are probably composed, not only of pigment, but also of a ground substance, which may be separated from the pigment by means of alkalies. Inorganic matter is present in this ground substance, possibly as a mordant to the pigment with which it is stained, or possibly as an additional (inorganic) oxydase, which takes part in the oxidation of the chromogen, in the manner of some manganese salts.

In addition to this ground substance, there are, as will be seen later, two other bodies, which go to form the pigment, namely, a colourless chromogen and an oxidising enzyme. The hair of an animal may therefore be colourless for one of three reasons: (1) The absence of either the chromogen or the enzyme; (2) the absence of both chromogen and enzyme; or (3) the presence of an inhibitor of the enzyme. That dominant white flowers, that is to say, white flowers which, in the first generation, give white instead .of coloured offspring when mated to colour, are due to an inhibitor has already been shown. That a chromogen is present in the white hairs of the white Angora cat, the English, Dutch, and albino rabbit, as well as in the white belly of the wild rabbit, may be seen

A B



C D

FIGURE 140.
Black Mouse.

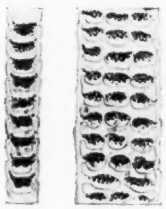


FIGURE 141.
Blue Mouse.

A comparison of C and D with Figure 141 shows that there is little difference between the pigment content of black and blue hairs. The medullary cells filled with pigment granules may be seen surrounded by canals from which the air has been expelled.

A shows the hair with the central portion in focus.
B. The same hair with the periphery in focus.
The pigment granules which absorb the light before it is reflected by the vacuoles may be seen lying in rows within the fibrils.
C and D are normal black hairs from which the air has been expelled by caustic soda.

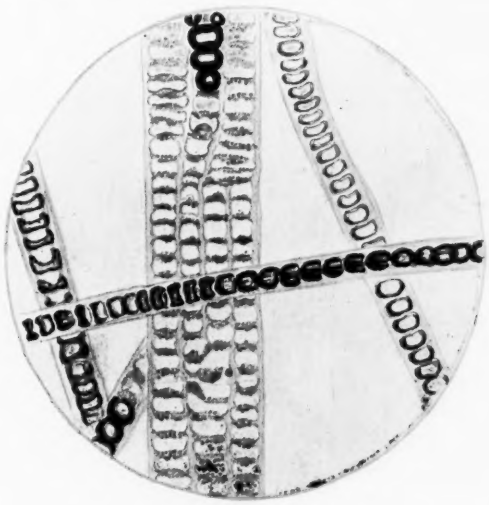


FIGURE 142.
White Hair from Black English Rabbit. × 500.
Stained with methyl-violet. The air has been partly expelled from the largest hair, showing clearly the stained granular substance or chromogen.

E F

FIGURE 143.
E shows a diagrammatic sketch of an Agouti hair.
F shows the same of a Steel.
The only portions of the hairs visible when they are lying on the animal are the black and yellow tips.

FIGURE 144. Silver-fawn Mouse.

FIGURE 145. Chocolate Mouse.

Seen by reflected light. The vacuoles appear white, and may be seen more obscured by the structure of the hair in the chocolate mouse than in the silver-fawn.

All Figures with the exception of 143 are × 500.

A. M. Kelly del., 1914.

XUM

FIGURE 146.

FIGURE 147.

Fairy Shrimps (*Chirocephalus diaphanus*) swimming in various positions.

From flashlight photographs *by Hubert H. Poole and Wilfred Mark Webb.*

from the fact that there are present in these white hairs uncoloured granular bodies, in the exact position occupied by the granule groups in coloured hair.* Where the air has been expelled, in Figure 142, they may be clearly seen, after staining in methyl violet, as groups of pigment granules.

Whiteness in these cases is therefore probably due to the presence of an inhibitor, and, in the case of the albino rabbit, to the absence of an oxydase. The white hair of the belly of *Mus sylvaticus*, as well as of albino and piebald mice, possesses, however, no granular body which is capable of taking an artificial stain, and whiteness in these cases is probably due to the absence of chromogen.

Black animals contain black and some chocolate pigment; chocolate and fawn animals contain chocolate and no black; yellow and cream animals contain yellow pigment, with the addition of some chocolate and black pigment, if the animal is heterozygous for black. The agouti, or common wild form of the rat, rabbit, or mouse, is a mixture of all three pigments; most of the hairs have a blue base, then a black and chocolate bar, next a yellow bar, and finally, as a rule, a chocolate tip. Occasionally, in certain mice called reversed sables, the yellow and black bars are interchanged. There is also in rabbits a modification of the agouti, called steel, which lacks the white belly and scut. The hairs have a much narrower bar of yellow, and more developed bars of black, which gives the animal a much darker appearance. A diagrammatic representation of a steel and of an agouti hair is shown in Figure 143. White hairs, such as are found in albinos and piebalds, owe their brilliancy entirely to the large air-content and to the entire absence of pigment.

THE ACTION OF CHEMICALS.

The keratin of the hair is extremely resistant to the action of all reägents, and is only dissolved by the action of caustic alkalies and strong mineral acids. Under the action of caustic soda the yellow pigment is first dissolved, forming a clear yellow solution; next the chocolate, forming a warm brown solution; and, finally, the black pigment granules settle to the bottom, undissolved. None of these solutions give absorption bands.

A very simple technique for examining hairs is to place them under a cover-slip, under which a drop of ten per cent. caustic soda has been run. The alkali immediately drives out the air from the vacuoles, loosens the epithelial cells, and permits the colour of the granules to be observed, without the obscuring effect of the vacuoles.

* If white hair of the English or albino rabbit is treated as if for the extraction of the black pigment, there results in both cases a small quantity of a greyish substance which turns black when dried on the water-bath, and is in appearance somewhat similar to the black pigment. The greyish substance also contains an appreciable amount of cholesterin.

THE FAIRY SHRIMP.

By WILFRED MARK WEBB, F.L.S.

OUR readers may recollect that some years ago (see "KNOWLEDGE," Volume XXXIII, 1910, page 169) the appearance of the Fairy Shrimp, *Chirocephalus diaphanus*, at Eton was recorded, and a description given of the animal. Later on (see "KNOWLEDGE," Volume XXXIV, 1911, page 466) we reproduced some illustrated notes made in the year 1762, which dealt with the occurrence of the crustacean at Norwich. Considerable interest was also aroused at one of the meetings of the Royal Microscopical Society (see *J. R. Mic. Soc.* June 1913, page 250) by the exhibition of a large series of preparations illustrating the development of *Chirocephalus* made by Mr. H. J. Waddington, who, we believe, obtained his material from Cornwall.

It seems that every year since 1910 a few specimens of the Fairy Shrimp have been seen at Eton. During 1913, however, the form was very abundant, and in the winter the specimens grew to a size considerably larger than had previously been noticed. The object of this note is to record these facts as well as to chronicle that the writer succeeded last summer in hatching out and rearing a number specimens from mud collected in 1910, when the small pool in which the crustaceans were first observed had dried up. From this it is evident that the eggs may remain dormant for three years at least.

The accompanying illustrations are from photographs (see Figures 146 and 147) taken by Mr. H. H. Poole and the writer after a considerable amount of experimenting. Fairy Shrimps normally swim about continually, back downwards, with their leaf-like appendages always in motion. It is therefore a difficult matter to photograph them when they are alive and healthy. Figures 146 and 147 were, however, obtained by putting a glass dish containing a number of active Fairy Shrimps on to a piece of black velvet and taking the pictures by flashlight with one of Messrs. W. Watson & Sons' Holostigmat lenses working at $f/4{\cdot}6$.

XUM

THE FACE OF THE SKY FOR JUNE.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

TABLE 23.

Date.	Sun. R.A.	Sun. Dec.	Moon. R.A.	Moon. Dec.	Mercury. R.A.	Mercury. Dec.	Venus. R.A.	Venus. Dec.	Mars. R.A.	Mars. Dec.	Jupiter. R.A.	Jupiter. Dec.	Uranus. R.A.	Uranus. Dec.
Greenwich Noon.	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m	°	h. m.	°	h. m.	°
June 2	4 38·1	N.22·1	11 32·5	N. 1·8	5 54·2	N.25·6	6 38·7	N.24·7	9 17·9	N.17·3	21 39·1	S.14·8	20 56·6	S. 18.0
,, 7	4 58·6	22·7	16 12·6	S. 26·2	6 31·2	25·3	7 5·1	24·3	9 28·9	16·3	21 39·6	14·8	20 56·3	18·0
,, 12	5 19·3	23·1	21 14·0	S. 18·2	7 2·6	24·4	7 31·2	23·6	9 39·8	15·4	21 39·7	14·8	20 56·0	18·0
,, 17	5 40·1	23·4	0 54·9	N. 9·2	7 28·1	23·0	7 56·8	22·6	9 50·8	14·4	21 39·5	14·9	20 55·5	18·1
,, 22	6 0·9	23·5	5 0·0	N.27·7	7 47·0	21·4	8 22·0	21·3	10 1·8	13·3	21 39·0	14·9	20 55·0	18·1
,, 27	6 21·7	N.23·4	9 40·4	N.15·4	7 58·9	N.19·7	8 46·6	N.19·9	10 12·9	N.12.3	21 38·2	S.15·0	20 54·4	S. 18·1

TABLE 24.

Date.	Sun. P	Sun. B	Sun. L	Moon. P	Mars. P	Mars. B	Mars. L	Mars. T	Jupiter. P	Jupiter. B	Jupiter. L_1	Jupiter. L_2	Jupiter. T_1	Jupiter. T_2
Greenwich Noon.	°	°	°	°	°	°	°	h. m.	°	°	°	°	h. m.	h. m.
June 2	−15·2	−0·4	23·6	+21·8	+1·2	+18·2	208·0	10 25 *e*	−21·1	+0·2	62·3	224·9	8 7 *e*	5 47 *m*
,, 7	13·3	+0·2	317·5	+10·2	2·9	19·0	159·6	1 4 *m*	21·1	0·2	132·0	256·5	8 23 *m*	2 50 *e*
,, 12	11·2	0·8	251·3	−16·0	4·6	19·8	111·1	4 23 *m*	21·1	0·3	201·9	288·2	4 19 *e*	4 2 *m*
,, 17	9·1	1·4	185·1	−21·6	6·3	20·5	62·6	7 43 *m*	21·1	0·3	271·8	320·0	2 24 *e*	11 1 *e*
,, 22	6·9	2·0	118·9	− 6·1	8·0	21·2	14·0	11 2 *m*	21·0	0·3	341·7	351·8	2 39 *m*	0 13 *e*
,, 27	− 4·6	+2·5	52·7	+17·6	+9·7	+21·9	325·4	2 22 *e*	−21·0	+0·3	51·8	23·7	8 25 *e*	1 25 *m*

P is the position angle of the North end of the body's axis measured eastward from the North Point of the disc. B, L are the helio-(planeto-)graphical latitude and longitude of the centre of the disc. In the case of Mars, T is the time of passage of Fastigium Aryn across the centre of the disc. In the case of Jupiter, System I refers to the rapidly rotating equatorial zone, System II to the temperate zones, which rotate more slowly. To find intermediate passages of the zero meridian of either system across the centre of the disc, apply to T_1, T_2 multiples of $9^h\ 50^m{\cdot}4$, $9^h\ 55^m{\cdot}6$ respectively.

The letters *m*, *e*, stand for morning, evening. The day is taken as beginning at midnight.

THE SUN reaches the Solstice at 7 a.m., on 22nd, when Summer begins and the day is longest. Its semi-diameter diminishes from 15′ 48″ to 15′ 45″. Sunrise changes from $3^h\ 52^m$ to $3^h\ 48^m$; sunset from $8^h\ 4^m$ to $8^h\ 18^m$. There is no real night in June.

MERCURY is an evening star. Semi-diameter 3″ to 5″. Illumination diminishes from $\frac{4}{5}$ to $\frac{1}{5}$. In elongation 24° 55′ E on 19th, 10′ South of Neptune on evening of 25th.

VENUS is an evening star, $\frac{6}{7}$ of disc illuminated. Semi-diameter 6″. Occulted by Moon on 26th (see below). 2° 14′ North of Neptune on morning of 17th.

THE MOON.—First Quarter $1^d\ 2^h\ 3^m$ *e*; Full $8^d\ 5^h\ 18^m$ *m*. Last Quarter $15^d\ 2^h\ 20^m$ *e*. New $23^d\ 3^h\ 33^m$ *e*. First Quarter $30^d\ 7^h\ 24^m$ *e*. Perigee $5^d\ 11^h$ *e*. Apogee $17^d\ 9^h$ *e*, semi-diameter 16′ 29″, 14′ 47″ respectively. Maximum Librations, 7^d 7° N, 11^d 7° W, 21^d 7° S, 25^d 5° E, July 4^d 7° N. The letters indicate the region of the Moon's limb brought into view by libration. E., W. are with reference to our sky, not as they would appear to an observer on the Moon (see Table 27).

MARS is advancing through Cancer and Leo, 45′ N. of Regulus on 23rd. Occulted by Moon May 30th, 5^h *e*. The semi-diameter during June diminishes from 2″·6 to 2″·3. The unilluminated lune is on the East: its width diminishes from $\frac{1}{2}$″ to $\frac{1}{3}$″.

JUPITER is a morning star in Capricornus; it passes Stationary Point on 11th. Polar semi-diameter, 20″·5.

Configuration of satellites at 2^h *m* for an inverting telescope.

TABLE 25.

Day.	West.	East.	Day.	West.	East.
June 1	2 ○	134	June 16	1 ⊙	24
,, 2	$\frac{1}{2}$ ○	24	,, 17	3 ○	124
,, 3	3 ○	124	,, 18	321 ○	4
,, 4	32 ○	4 ●	,, 19	32 ○	14
,, 5	1 ○	4 3 ● 2 ●	,, 20	○	324 1 ●
,, 6	⊙	123	,, 21	1 ⊙	$\frac{4}{5}$
,, 7	412 ○	3	,, 22	2 ○	143
,, 8	42 ○	13	,, 23	14 ○	32
,, 9	413 ○	2	,, 24	43 ○	12
,, 10	43 ○	12	,, 25	4321 ○	
,, 11	4321 ○		,, 26	432 ○	1
,, 12	43 ⊙	2 ●	,, 27	4 ○	32 1 ●
,, 13	4 ○	132	,, 28	41 ○	23
,, 14	124 ○	3	,, 29	42 ○	13
,, 15	2 ○	143	,, 30	41 ○	23

The following satellite phenomena are visible at Greenwich, $3^d\ 3^h\ 31^m\ 10^s$ *m* I. Sh. I.; $5^d\ 0^h\ 15^m\ 4^s$ *m* I. Sh. E.; $1^h\ 15^m\ 3^s$ *m* III. Ec. D.; $1^h\ 29^m\ 16^s$ *m*, I. Tr. E.; $6^d\ 2^h\ 14^m\ 56^s$ *m*, IV. Tr.

E.; $11^d\ 2^h\ 38^m\ 15^s\ m$, I. Ec. D.; $11^d\ 11^h\ 52^m\ 48^s\ e$, I. Sh. I.; $12^d\ 1^h\ 3^m\ 7^s\ m$, I. Tr. I.; $1^h\ 30^m\ 59^s\ m$, II. Ec. D.; $2^h\ 8^m\ 31^s\ m$, I. Sh. E.; $3^h\ 18^m\ 56^s\ m$, I. Tr. E.; $13^d\ 0^h\ 37^m\ 54^s\ m$, I. Oc. R.; $14^d\ 1^h\ 34^m\ 56^s\ m$, II. Tr. E.; $15^d\ 11^h\ 47^m\ 4^s\ e$, III. Tr. I.; $16^d\ 3^h\ 24^m\ 46^s\ m$, III. Tr. E.; $19^d\ 1^h\ 46^m\ 9^s\ m$, I. Sh. I.; $2^h\ 51^m\ 37^s\ m$, I. Tr. I.; $20^d\ 2^h\ 26^m\ 45^s\ m$, I. Oc. R.; $20^d\ 11^h\ 34^m\ 36^s\ e$, I. Tr. E.; $21^d\ 1^h\ 5^m\ 46^s\ m$, II. Tr. I.; $1^h\ 48^m\ 31^s\ m$, II. Sh. E.; $22^d\ 3^h\ 31^m\ 43^s\ m$, IV. Sh. I.; $22^d\ 11^h\ 6^m\ 53^s\ e$, III. Sh. I.; $23^d\ 2^h\ 44^m\ 10^s\ m$, III. Sh. E.; $3^h\ 23^m\ 1^s\ m$, III. Tr. I.; $26^d\ 3^h\ 39^m\ 30^s\ m$, I. Sh. I.; $27^d\ 0^h\ 55^m\ 9^s\ m$, I. Ec. D.; $27^d\ 11^h\ 5^m\ 45^s\ e$, I. Tr. I.; $28^d\ 0^h\ 24^m\ 3^s\ m$, I. Sh. E.; $1^h\ 21^m\ 59^s\ m$, I. Tr. E.; $1^h\ 30^m\ 7^s\ m$, II. Sh. I.; $3^h\ 29^m\ 23^s m$, II. Tr. I.; $30^d\ 0^h\ 40^m\ 0^s\ m$ II. Oc. R.; $3^h\ 5^m\ 38^s\ m$ III. Sh. I.

The eclipses will take place to the left of the disc in an inverting telescope, taking the direction of the belts as horizontal.

SATURN and NEPTUNE are too near the Sun for convenient observation.

URANUS is a morning star, but badly placed; near Moon on morning of 12th.

COMETS.—See "Notes on Astronomy."

METEOR SHOWERS (from Mr. Denning's List):—

Date.	Radiant. R.A.	Radiant. Dec.	Remarks.
	°	°	
May-30-Aug...	333	+ 28	Swift, streaks.
May-June ...	280	+ 32	Swift.
May-July ...	252	− 21	Slow, trains.
June-Aug. ...	310	+ 61	Swift, streaks.
June-Sept. ...	335	+ 57	Swift.
June-July ..	245	+ 64	Swift.
June-Aug. ...	303	+ 24	Swift.

In the cases where the radiant is stated to be active for several months, there is a difference of opinion as to whether it can be regarded as a single shower or a combination of several.

DOUBLE STARS AND CLUSTERS.—The tables of these given two years ago are again available, and readers are referred to the corresponding month of two years ago.

VARIABLE STARS.—The list will be restricted to two hours of Right Ascension each month. The stars given in recent months continue to be observable (see Table 26).

TABLE 26. NON-ALGOL STARS.

Star.	Right Ascension.	Declination.	Magnitudes.	Period.	Date of Maximum.
	h. m.	°		d.	
X Herculis	16 1	+47 ·5	5·8 to 7·2	irregular.	
R Herculis	16 2	+18 .6	8·0 to 14·7	317·7	April 14.
SX Herculis	16 4	+25 ·1	7·9 to 9·2	100·55	June 18.
W Coronae	16 13	+38 .0	7·8 to 13·5	238	July 26.
ξ Herculis	16 26	+42 ·0	4·7 to 5·5	unknown	
SS Herculis	16 29	+ 7 ·0	8·0 to 12·5	103·9	May 23.
S Ophiuchi	16 29	−17 .0	8·3 to 13·5	233·69	June 15.
S Draconis	16 41	+55 ·1	7·5 to 10·0	300	June 22.
u Herculis	17 14	+33 ·2	4·8 to 5·3	2·05102	Algol Star.
Z Ophiuchi	17 15	+ 1 ·6	7·6 to 12·6	349·3	May 26.

Minimum of u Herculis June $2^d\ 3^h{\cdot}7\ m$. Others may be found from period.

Principal Minima of β Lyrae June $3^d\ 11^h\ m$, $16^d\ 9^h\ m$, $29^d\ 7^h\ m$. Period $12^d\ 21^h{\cdot}8$.

TABLE 27. Occultations of stars by the Moon visible at Greenwich.

Date.	Star's Name.	Magnitude.	Disappearance. Time.	Disappearance. Angle from N. to E.	Reappearance. Time.	Reappearance. Angle from N. to E.
1914.			h. m.	°	h. m.	°
June 4 ...	83 Virginis	5·6	11 38 e	184	0 4 m*	229
,, 4 ...	85 Virginis	6·1	11 42 e	56	0 15 m*	354
,, 5 ...	BAC 4814	6·5	6 47 e	90	7 45 e	330
,, 7 ...	BAC 5603	6·0	9 20 e	165	9 55 e	224
,, 10 ...	τ Sagittarii	3·5	2 59 m	84	4 9 m	242
,, 13 ...	δ Capricorni	3·0	0 19 m	118	1 2 m	190
,, 20 ...	47 Arietis...	5·8	—	—	1 31 m	195
,, 21 ...	27 Tauri	3·7	—	—	1 48 m	205
,, 21 ...	28 Tauri	5·2	—	—	1 57 m	228
,, 26 ...	Venus	—	7 51 m	173	8 12 m	213
,, 26 ...	Wash. 626	7·3	8 27 e	163	—	—
,, 27 ...	Wash. 672	7·0	9 53 e	153	—	—

From New to Full disappearances take place at the Dark Limb, from Full to New reäppearances.

The asterisk indicates the day following that given in the date column.

Attention is called to the occultation of Venus on the morning of the 26th: it will take place in daylight at a somewhat low altitude in the east, the Moon being a thin crescent, $2\frac{3}{4}$ days old.

XUM

SPORE DISPERSAL IN THE LARGER FUNGI.

By SOMERVILLE HASTINGS, M.S., F.R.C.S.

(With illustrations from photographs by the writer.)

(Continued from page 123.)

VERY different from the species so far described, whose spores are distributed singly by the wind, are the Bird's Nest fungi. Within the cup-shaped "nests" flattened masses of spores become developed, each surrounded by a dense protective covering which is itself attached to the nest by a fibrous cord. When dry this cord is brittle, but when moist it is so elastic that it can be stretched out five or six inches before it breaks. The loose tissue between the eggs soon disintegrates, and later on the elastic cords give way and the spore masses become distributed. Last of all, the coverings of the spore masses decompose and the spores germinate. Two forms are illustrated in Figures 150 and 153. The Common Bird's Nest (*Crucibulum vulgare*) differs from the Striated Bird's Nest (*Cyathus striatus*), not only in the absence of striations on the inside of the nest, but also by possessing no depressed area where the cords are attached to the "eggs." Both species grow on rotting twigs. The specimen of the Common Bird's Nest here shown was kept growing on some old canvas for several months, and it was very interesting to watch its development.

We have next to consider fungi which shoot out their spores in masses to a considerable distance. The Catapult Fungus (*Sphaerobolus stellatus*) (see Figure 152) is one of the best known of these. It is a tiny little thing, not much larger than a pin's head, but fortunately it grows in groups surrounded by more or less whitish mycelium, otherwise it would be very difficult to find. It is not uncommon on decaying wood, and in its early stages of development each tiny fungus looks like a little white or orange-coloured seed. The body of the fungus is formed of two layers, or coats, which are but slightly adherent to each other, except on the top. Enclosed by the inner coat is a sticky mass of spores. When the fungus is ripe both coats split radially above, so that a little star-like cup is formed, surrounded by half a dozen rays, with a dark, shining mass of spores at the bottom of it. Very soon the inner coat, which is only attached to the outer edge at the tips of the rays, suddenly turns inside out, driving before it the mass of spores. The opalescent inner coat now looks like a tiny pearl. The shooting is too rapid to be followed by the eye, but is so efficient that the little brown mass of spores is projected a distance of one or two feet. It is a fascinating process to watch, and should the observer have but little time or patience at his disposal an open cup can be made to shoot out its spores by lightly pressing on its outer coat with the point of a pin.

Several of the smaller fungi which grow on dung also shoot their spores. In *Ascobolus immersus*, an Ascomycete, the eight large spores of each ascus are shot out, sticking together as a single mass, to a distance of about a foot. Two interesting facts have been made out about this tiny fungus. The little plant always turns towards the light and shoots its spores in this direction, and spore discharge is periodic and only occurs by day. Remembering that the fungus grows on dung, it is easy to see that the spores are discharged only in the direction of the light, so that they may pass clear of neighbouring obstructions and fall some distance from the parent plant. They are discharged only by day, because only at this time is the directing action of light present. *Pilobolus crystallinus* also comes up on dung as a tiny crystalline droplet, with a little black spot on top. Like *Ascobolus*, it always turns towards the light before shooting its spores; but it differs from *Ascobolus* in that each spore-mass consists of some hundreds of spores and not eight only. Further, the spore-masses are shot to a longer distance, and *Pilobolus longipes* will project its spores a distance of from three to six feet. Sometimes the sound of the spore discharge can actually be heard. Buller describes how, with *Pilobolus Kleinii*, he was able to make out two sounds: first a little click as the spore mass left the fungus, and then a further sound when the projectile struck the side of the containing dish or other object. An interesting demonstration of the accuracy of the aim of *Pilobolus* can be made by covering the dung on which it grows with a cardboard box having a circle, say, two inches in diameter, cut in its centre, and a small piece of glass as cover to this hole. A very large proportion of the little black spore-masses will be found within the glass-covered circle.

But what advantage, it may be asked, is it to fungi which grow on dung to project their spores to such long distances? In nature the spores shot out by the fungus usually fall on grass or other vegetation, and are then accidentally eaten by cattle and other herbivora, and, passing unaffected through the alimentary canals of these animals, and

FIGURE 148. Immature specimens of a Puffball (*Lycoperdon gemmatum*). No opening has yet formed on top.

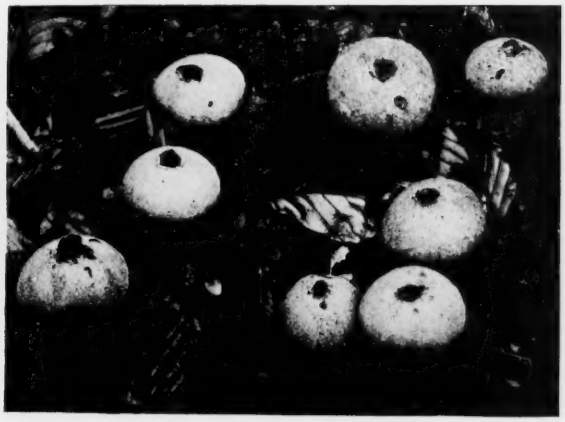


FIGURE 151. Mature specimens of a Puffball (*Lycoperdon gemmatum*).

FIGURE 149. The Star Puffball (*Geaster seriscus*).

FIGURE 152. The Catapult Fungus (*Sphaerobolus stellatus*), which shoots its spore masses to a distance of one or two feet. ×3.

FIGURE 150. The Common Bird's Nest (*Crucibulum vulgare*) growing on old canvas. ×2.

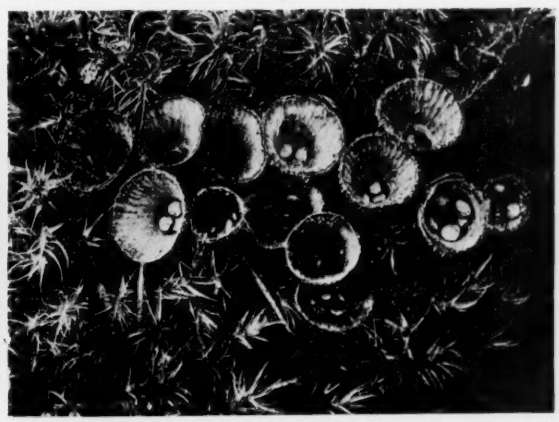


FIGURE 153. The Striated Bird's Nest (*Cyathus striatus*).

FIGURE 154. *Anellaria separata.* A common fungus which grows almost exclusively on dung.

FIGURE 157. The Stinkhorn (*Ithyphallus impudicus*) with flies devouring the mucus.

FIGURE 155. *Boletus chrysenteron*, showing tooth-marks of a squirrel.

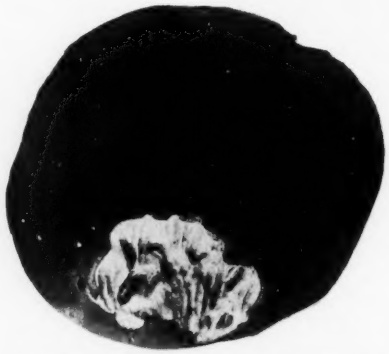


FIGURE 158. *Boletus badius*, showing tooth-marks of a squirrel.

FIGURE 156. The Stinkhorn (*Ithyphallus impudicus*) with immature specimens, one in section.

FIGURE 159. The Dog Stinkhorn (*Mutinus caninus*) in various stages of development and in section.

becoming thoroughly mixed with decomposing vegetable matter, are deposited under ideal conditions for germination and growth. Many fungi have been grown from the contents of the intestines of recently killed rabbits, extracted under conditions which made it impossible that any spores should have reached them through the air. Besides these tiny fungi a large number of dark-spored toadstools of the genera *Anellaria*, *Coprinus*, and *Panaeolus* (see Figure 154) are also found almost exclusively on the dung of horses and cattle; indeed, the existence of not a few of these fungi seems to be entirely dependent on that of some one or other of the herbivora. Occasionally, of course, the spores may be carried to the dung directly by the wind, but much more usually they are first deposited on grass or other herbage, and are then swallowed by the animal and pass unharmed through its body.

We see, therefore, that some toadstools make use of both wind and animal agencies to effect their spore dispersal. When we consider the vast number and small size of the spores of many fungi we shall understand how frequently they must become deposited on the grass, leaves, and fruits which form the regular foods of beasts, birds, and insects. It is quite possible that the spores of a large number pass unharmed through the alimentary canals of these creatures, and are thus deposited under conditions peculiarly suitable for their germination and growth.

But not only are the spores of many fungi unconsciously eaten by animals, but certain other fungi which grow underground are themselves eagerly sought for by pigs and other animals and greedily devoured. The fact that the edible truffles are only strong-smelling when quite mature, and filled with ripe spores, suggests that this must be a coöperative process, and that it is really to the interest of the fungus to be thus devoured. Truffles are also eaten by a variety of beetle (*Leiodes cinnamomea*), and it may be that this creature is important in the dispersal of their spores. It is also possible that the smaller mammals, such as rabbits and squirrels, may also assist in the spore distribution of certain fungi. During the past year I found three different species of Boletus showing unmistakable evidence of having been eaten by squirrels (see Figures 155 and 158), and also saw a species of Flammula (a gill-bearing toadstool, with rust-coloured spores), marked by the claws of a small animal, fall from a branch of a tree on which a squirrel was sitting. The fruits of *Fomes annosus* (see Figure 116) are usually developed on the exposed roots of Conifers on which the plant grows. I have on several occasions seen them forming part of the roof or sides of rabbit-burrows, and would suggest that the rabbits which brush against the fungus must assist in its spore-dispersal, chiefly through the air-currents that they produce in passing.

There are three British fungi which show an unmistakable adaptation for the dispersal of their spores by insects. Two of these are fairly common and one is exceedingly rare. Two or three closely related species from Australia have been accidentally introduced into this country, but do not seem to be spreading. The Common Stinkhorn (*Ithyphallus impudicus*) (see Figures 156 and 157) is very common in woods. In its early stages it closely resembles an ordinary hen's egg with a softened shell; indeed, the fungi in this stage are spoken of as "ghost's eggs" by the peasants of Kent. The "egg" is white, and projects slightly above the ground. Its lower extremity is attached to a branched white cord, which can sometimes be traced for one or two feet through the soil, and may lead to a second "egg." The branched cord is the mycelium, or fungus plant, while the "egg" is its fruit. The "egg" grows until mature, when the outer gelatinous coat ruptures at the top, and the stalk, which had previously resembled a compressed sponge, rapidly expands until, in two or three hours, it has increased in length from an inch and a half to five or six inches. Carried aloft by the white stalk is a conical cap which is also white, but its colour is at first obscured by a dark-green, glutinous substance in which are embedded the spores. The dark-green gluten is sweet to the taste, and is at first fairly solid. But almost as soon as the elongation of the stem is complete it begins to liquefy and form droplets, and it is now that the object of the vertical and horizontal projections on the cap become clear. About this time also the whole fungus, and especially the slimy material on top, which had at first only a faint and not unpleasant smell, begins to exhale a most foetid and disgusting odour. Wasps, blue-bottles, and smaller flies are attracted by the smell, and eagerly devour the dark-green gluten with its contained spores; and so greedy are they that comparatively rarely do we find a fully developed Stinkhorn with any trace of the dark slime upon it. The spores pass unchanged through the insect's body, and in this way dissemination is effected. Spores from the excreta of flies that had been fed on this fungus were placed in tubes on sterilised earth and germinated in two months, producing mycelium. The Dog Stinkhorn (*Mutinus caninus*) (see Figure 159) also grows in woods, but is less abundant than the Common Stinkhorn. It is a smaller fungus, and has no definite cap at the end of the stem. Usually it has no smell, but sometimes a faint odour can be detected. The last half-inch of the stem is covered with dark olive-green mucus, which is itself at first overlaid by a greyish film. When the spore-containing mucus is removed by the small flies that feed upon it the bright-red extremity of the stalk becomes visible. The Lattice Fungus (*Clathrus cancellatus*) is extremely rare. When mature a hollow sphere, formed by dark-red anastomosing branches, is seen. On this framework is spread the dark-green, spore-containing mucus. The whole thing is abominably foetid.

XUM

The Devil's Snuff-box (*Scleroderma vulgare*) (see Figure 161) is a puffball, with a thick coat, which never spontaneously ruptures, and resists decay for a long time. In its early stages of development the interior is firm and solid, but later a dark-brown, powdery mass of spores is developed in it. Specimens found in nature have often a number of holes about a quarter of an inch in diameter in the lower part of their leathery coverings; these are the work of beetles, which eat their way into the fungus, and are probably of considerable assistance to the plant in the dispersal of its spores.

But toadstools, and particularly the gills of those that possess them, are very frequently eaten by slugs, and the observations of Voglino tend to show that this is not altogether disadvantageous to the fungus plant; for the germinating spores of species of *Russula* and *Lactarius* (see Figure 160) were found in the digestive tracts of slugs fed on these toadstools. Further, the spores of other species that would not germinate on ordinary culture media were found to do so readily in the fluid from the digestive tract of the slug. Slugs are eaten by many birds which often fly long distances, and it is possible that in this way the wide distribution of some species of fungus is to be explained. The germinating spores of species of *Lactarius* and *Russula* have been actually found in the digestive tracts of toads caught in pine woods, and were probably derived from the slugs that they had eaten. Perhaps the most striking of Voglino's observations was the following. Ten specimens of a toadstool (*Hebeloma fastibile*) were enclosed as they grew, and four starved slugs introduced. The toadstools were eaten, especially their gills. One of the slugs was killed, and germinating spores of *Hebeloma fastibile* found in its digestive tract. The other three were left in the enclosure, which was watered with sterilised water, and kept enclosed for nearly a year. Specimens of *Hebeloma* were then found to be more numerous within it than elsewhere in the neighbourhood. Slugs are very careful, however, as to the variety of toadstool that they care to tackle. Experiments with slugs kept without food for a couple of days showed that, while the Stump Tuft (*Armillarea mellea*) (see Figure 77), the Emetic Russule (*Russula emetica*), and the Scarlet Fly-cap (*Amanita muscaria*) (see Figure 162) were readily eaten, the Sulphur Tuft (*Hypholoma fasciculare*) and the Melon Hygrophorus (*Hygrophorus pratensis*) remained practically untouched. The Death-cup (*Amanita phalloides*) (see Figure 165), the most poisonous of British toadstools, is sometimes found eaten by slugs, and it will be seen from the above that other forms which are poisonous to ourselves do not appear to be harmful to less highly organised creatures. It seems probable, therefore, that species of *Lactarius* and *Russula* are greatly assisted by slugs in their spore dispersal, and it is possible that other fungi find these creatures of secondary value also. In all these forms, however, the wind is of first importance.

Lastly we come to fungi whose spores are distributed by insects on which they themselves parasitically grow. The Caterpillar Fungus (*Cordyceps militaris*) (see Figure 163) is a truly marvellous plant. The club-shaped fruit shown in the illustration is bright scarlet-red, and stands up about an inch above the ground. It is covered with tiny pits from which the ascospores are shed. The fungus is parasitic on caterpillars, and its spores enter the unfortunate insect either through the spiracles or are swallowed with its food. The infection takes place slowly, and the insect has usually passed into the chrysalis stage before it is killed by the fungus. Its body is then replaced by a dense web of fungus mycelium; but even in this state the outward form of the chrysalis is still, as a rule, visible, though it was lost in the specimen photographed. Before producing the fruit here illustrated the fungus often throws up a short-branched process, which buds off minute spores (conidia). In autumn the bright-red fructification appears above the surface of the ground in which the remains of the chrysalis lie buried. A larger form, *Cordyceps sinensis*, is sold in bundles, with the caterpillar still attached, as a regular article of diet in China, and can even be purchased in certain shops in London.

Though hardly one of the larger fungi, it is difficult to close without a brief description of *Empusa muscae* (see Figure 164), which causes so destructive a disease to the common house-fly. In late autumn and early winter it is very common to find dead flies sticking to looking-glasses, pictures, and window-panes. If these be closely examined each will be seen to be surrounded by a sort of halo, and if looked at with a pocket lens the halo will resolve itself into a number of small white spores. The fungus grows parasitically in the interior of the fly and slowly kills it. The fine threads of the mycelium then perforate the insect's body, and bud off the relatively large spores. These are shot out to a distance of a quarter to three-quarters of an inch by rupture of the filaments bearing them, and as they adhere to any object struck other flies readily become infected.

In conclusion, the writer feels compelled to acknowledge that very few of the observations recorded in the foregoing pages are really original. They are mainly the result of the work referred to in the following bibliography, especially that of A. H. R. Buller:—

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FIGURE 160. *Lactarius rufus*. A Toadstool with a white milky juice. Specimens of this genus are often found eaten by slugs.

FIGURE 163. The Caterpillar Fungus (*Cordyceps militaris*), which grows parasitically on the larvae of butterflies and moths.

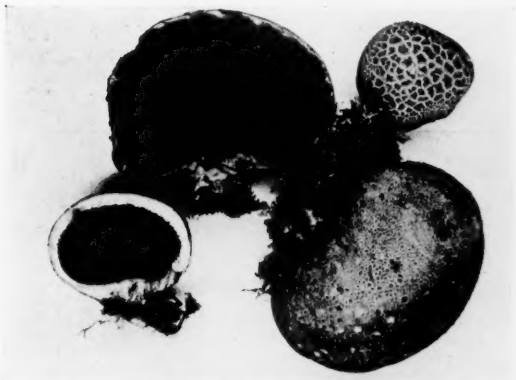


FIGURE 161. The Devil's Snuff-box (*Scleroderma vulgare*). A Puffball with a thick leathery coat which never spontaneously ruptures.

FIGURE 164. *Empusa muscae*, which grows parasitically on the common house-fly.

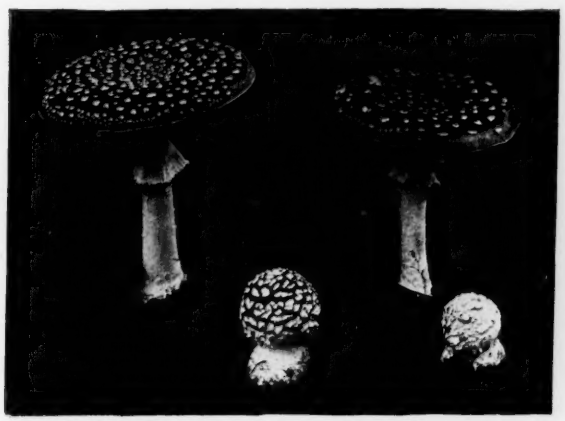


FIGURE 162. The Scarlet Fly-cap (*Amanita muscaria*). A brilliantly coloured but very poisonous toadstool.

FIGURE 165. The Death-cup (*Amanita phalloides*), the most deadly of all toadstools, which is responsible for nine-tenths of all deaths from fungus-poisoning.

XUM

FIGURE 166. Section of apple, showing starch grains; stained with iodine. × 200.

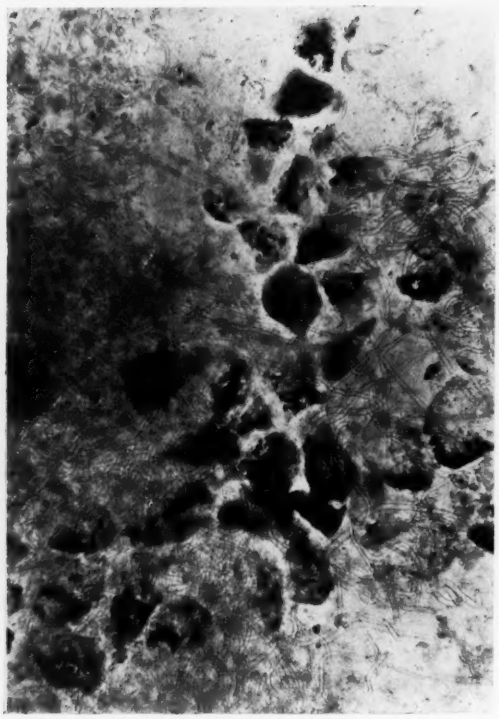


FIGURE 168. "Improved" raspberry jam, containing apple cells; stained with iodine. × 75.

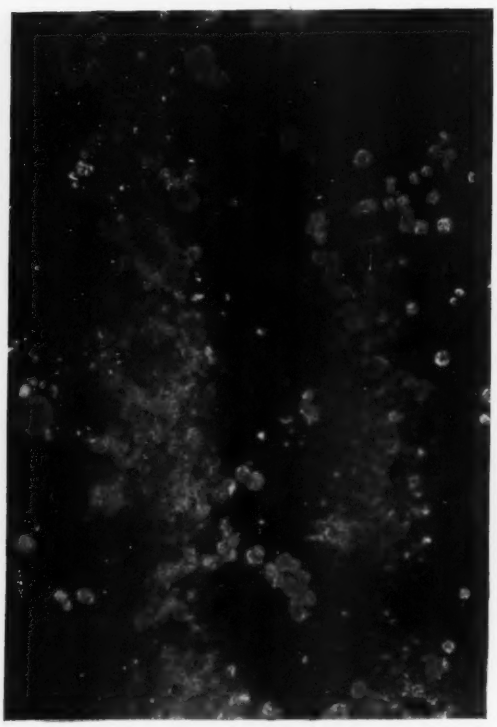


FIGURE 167. Pure raspberry jam, lead iodide reaction on a slide. × 200.

FIGURE 169. Improved strawberry jam, showing gooseberry cells. Seen by polarised light. × 75

MICROSCOPICAL AND COLLOIDAL EXAMINATION OF JAMS.

By ERNEST MARRIAGE, F.R.P.S.

THE analysis of these important foodstuffs to-day is not equal to the power in the hands of adulterators. Careful adulteration of a jam with a cheaper fruit jelly means a certain outlay in plant, but an expenditure of money in this direction enables manufacturers to adulterate, or, as they say, "improve," their jams and to defy analysts. Anyone who takes the trouble to record cases of prosecutions will see that the caught culprits are, as a rule, small firms; the larger and well-known makers, though often equally blameworthy, escape detection.

Chemical analysis is of little or no assistance in detecting the blending of two or more fruits in jam. Fruit acids are very nearly related, and impossible to isolate, whilst they occur in varying proportions in most fruits. Malic acid is not confined to apples, nor citric acid to lemons, and so on. Possibly it might be worth while to examine jams for oxalic acid, as an indication of rhubarb adulteration. The iodine test for starch is useful if an apple adulterant, which has not been thoroughly filtered, is employed, as many apple cells contain starch; but even a home-filtered apple jelly may fail to show the marked blue reäction. Figure 166 shows a section of apple stained with iodine: the numerous dark spots are starch grains. In the boiling to which the fruit is subjected the starch is broken up and diffused throughout the cell, but the cell walls are not broken, and the contents of the cell show the characteristic colour. Figure 168 is a specimen of "improved" raspberry jam in which the iodine test reveals the nature of the adulterant. Note the cells of apple containing starch, which are black in the figure. Gooseberries, another common diluent of the more costly jams, are free from starch, so iodine is no use in that connection.

Another chemical test consists in the introduction of alcohol into a solution of jam whereby the pectin is thrown out. The comparative absence of pectin is characteristic of strawberries, and affords some criterion of the purity of a strawberry jam: it is the alleged pretext for adulterating this preserve with gooseberry or apple jelly. Yet other fruits, rich in pectin, black currants, for example, are treated with an admixture of apple. Looking deeper for the common cause of both these sophistications, we find that apples or gooseberries are cheaper for the jam-maker to use than strawberries or black currants.

Useful quantitative records of adulteration of jams with apple pulp can sometimes be obtained by the iodine test and photography without the aid of a microscope; but as the amount of starch present in apples is variable, depending on the maturity or ripeness of the fruit—probably upon the variety as well—the results obtained are now and then disappointing. In any case the darkened cells are only a proportion of the whole, and must not be taken to represent the total adulteration. A lens of short focal length, say two inches, and a camera with a long extension are necessary. The sample to be tested is made up in the form of a microscope slide, and an enlarged negative, preferably of the whole of the preparation, is taken in the camera. With an enlargement of ten diameters the darkened apple cells can readily be seen and their number counted. To prepare the slide, a drop of jam, free from pips, is placed on a micro-slip and mixed with a trace of iodine solution; a three-quarter-inch circular cover-glass is placed on the jam, and pressed down with a cork five-eighths of an inch in diameter, until the layer imprisoned is as thin as possible. The slide is then ready for the photographer. An isochromatic plate should be used, in conjunction with a yellow screen, to cut out the blue rays. Records obtained in this way of a pure raspberry jam and one "improved" with apple are shown in Figure 170. The left semi-circle is the pure jam, whilst the dark oval specks in the other show the presence and frequency of the adulterants in the second sample. Micro-slides made in the above way are, of course, equally available for photomicrography, and the coloration of the apple cells makes them much easier to record (as we have seen above) than in their almost transparent, unstained condition; but the limited area included in a photomicrograph is insufficient to give even an approximate idea of the extent, though it affords positive proof of the existence of the adulteration.

Failing satisfactory chemical tests, the microscope offers a quick and ready method of picking out fruit adulterants, subject to the proviso that perfect filtration has not been employed. Microscopical examination of all foodstuffs is a highly important branch of analytical work. For investigating jams a high magnification is not required; an enlargement of fifty to one hundred diameters is generally sufficient. In making photomicrographic records it is well to keep to one standard magnification: by so doing there is less danger of confusion. The cells of apple are smaller than those of gooseberry or plum, but at a higher magnification might easily be mistaken for either of the latter less magnified.

When recourse is had to the microscope, three or four methods of examination are available, viz.,

by transmitted light, dark ground illumination, opaque illumination, and polarised light. Of these, without doubt, the polariscope is the best optical means of showing the fruit structure and cells in an unstained slide. I have dealt with the value of the iodine test for apple: the polariscope is especially useful in the detection of gooseberry. Gooseberry cells are large, but the main characteristic of the fruit is that a fair proportion—not all—of the cells show bright minute specks when the nicols of the polariscope are crossed. Figure 169 shows gooseberry cells in an "improved" strawberry jam. I do not know the nature of these specks: they are not crystals, the raphides of the microscopist.

There is no great need to dwell upon the special characteristics of more costly fruit, as in spite of the fact that jam-makers claim on their labels to improve their wares, they invariably do so with cheaper fruit. Minute hairs from the skin of the fruit are very apparent in raspberry (see the minute tubes in Figure 168) and loganberry jams, but are occasional only in blackberry or strawberry, and absent from apples, currants (red and black), gooseberries, and plums.

Familiarity with the appearance of pure jams is, of course, essential, and for this experience it is best to rely entirely on jams made at home. The number of manufacturers who make pure jams is small, and they are being forced out of the trade by fraudulent competition. Sections of the actual fruit, too, should be examined. These are not easy to prepare. Thin sections can be obtained by infiltration with paraffin or celloidin, but I think that the results so obtained are misleading, and that sections of the fresh fruit, say one hundredth of an inch (or more) thick, soaked in dilute formaldehyde and then mounted in glycerin jelly, are more suitable.

Though the use of the polariscope is of prime importance, the ordinary examination by transmitted light must in no wise be neglected. Dark-ground illumination, unless the polariscope is not available, is of minor importance. Opaque illumination by the Lieberkuhn, though useless for jams, is valuable for dealing with pips, or examining the surface of fruits or vegetables in their natural state. I shall have occasion again to refer to the Lieberkuhn below.

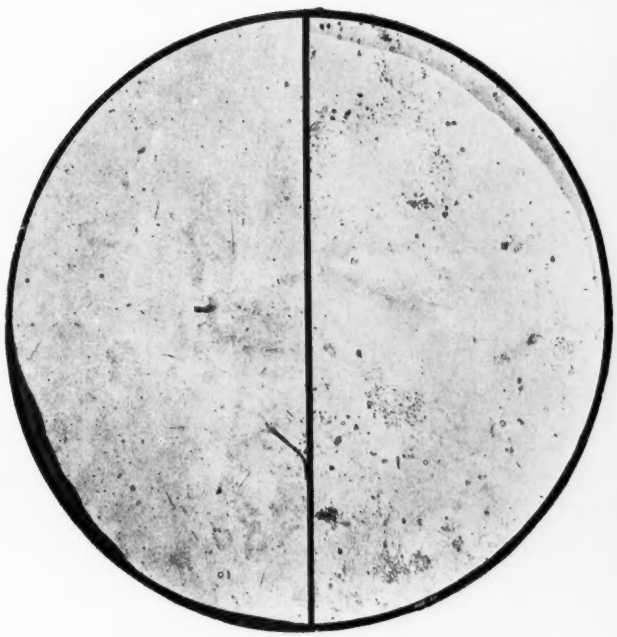
The examination of jams for incriminating fruit details is useful up to a certain point, but when the adulterant has been carefully filtered the microscopist may make his bow and gracefully retire from the contest with the adulterator, as the chemist has practically done at the outset. We have seen already, with the iodine test, that a combination of chemistry and microscopy has advantages over the individual sciences. In that case we were dealing with unfiltered jams; may not the same hold good with filtered jellies?

In February, 1911, Mr. Emil Hatschek read a paper, "A Study of some Reactions in Gels," before the Society of Chemical Industry (see the *Journal of the S.C.I.*, March 15th, 1911, No. 5, Vol. XXX), in which he showed that precipitates of certain insoluble salts in various gels differed, not only from precipitates obtained in corresponding aqueous solutions, but also among themselves. He suggested to me that a study of the precipitates formed in fruit jellies might give a clue to their origin, and so enable adulteration to be detected. As the lead iodide reäction gives very different results in gelatine and agar-agar, it seemed to offer the best chance of success, and though I have experimented a little in other directions, my investigations have been practically limited to this one reäction.

It is essential that the jelly tested be thoroughly filtered, so the precautions taken by the jam-faker to avoid detection are helpful rather than otherwise for our present purpose. Any fibres or vegetable *débris* in the jam affect the regular deposition of the precipitates. A convenient amount of jam for a test is thirty grammes, which should be dissolved in about three hundred cubic centimetres of hot distilled water. Dissolution is best performed in a flask in which the mixture can be boiled. The solution should be filtered whilst hot, by means of a suction filter, and the bright solution of jelly concentrated by heating until a standard boiling-point is reached: 225° F. is convenient. The weight of jelly is now taken, and enough potassium iodide is added thereto to make a five per cent. solution of the salt. In practice it is more convenient to add the potassium iodide in the form of a twenty per cent. solution, rather than try to dissolve the crystals in the jelly direct. Assuming that a solution is used, the correct proportion is mixed in with the jelly, which is reboiled to the standard temperature and then poured out into test tubes. Two inches of jelly in each tube will suffice.

Having reached this stage, it is better to defer the next operation—the introduction to the tubes of a twenty per cent. solution of lead nitrate—until the following day, in order that the jelly may set thoroughly. In the case of strawberry a delay of several days is desirable, in order to give the surface time to harden a little, otherwise the skin of the jelly will be broken, and the lead nitrate solution mechanically mixed, instead of diffused, in the upper part of the jelly. Another way of dealing with a tender jelly is to cover it with a thin layer of a stronger jelly. I have successfully used glycerin jelly for this purpose. This plan should only be regarded as a *pis aller*: the introduction into the test of a foreign colloid must be considered undesirable.

A few tests made in this way are shown in Figure 174. Reading from left to right, they are apple, apple and gooseberry (equal parts), gooseberry, loganberry, and raspberry jellies. Apple jelly shows little or no tendency to yield the layers of lead iodide precipitates, which are a common feature in this branch of research. Layers are numerous in gooseberry, and, as might be expected, this formation



Pure. "Improved."

FIGURE 170. Comparison of pure and "improved" raspberry jams. Iodine test. ×5.

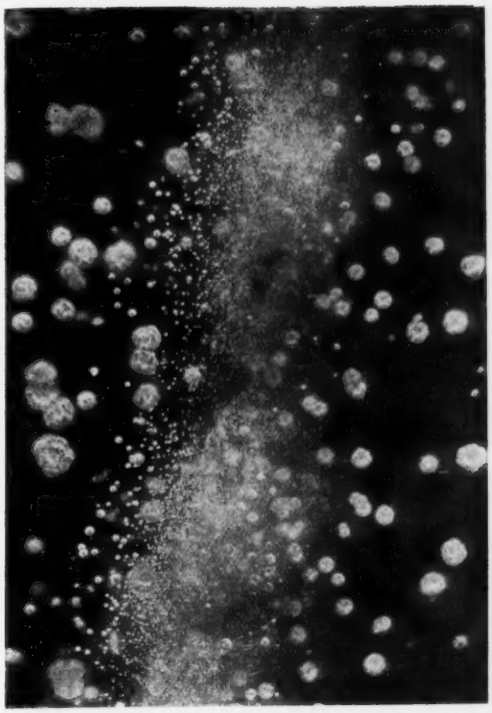


FIGURE 172. Raspberry containing apple, lead iodide reaction on a slide. ×200.

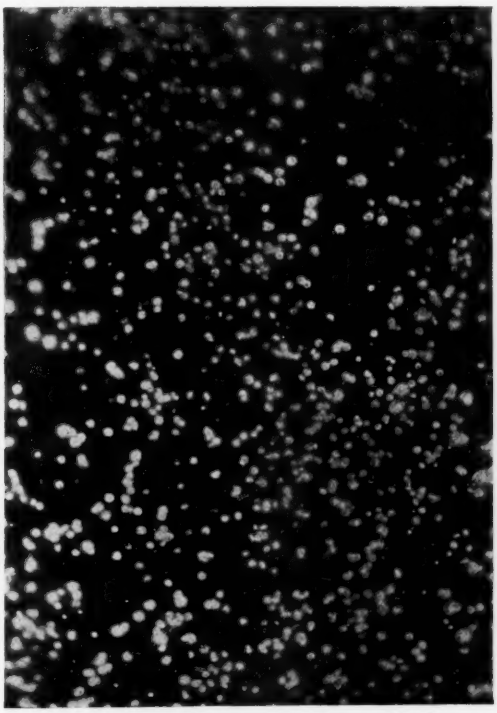


FIGURE 171. Raspberry containing ·2 % of agar-agar, lead iodide reaction on a slide. ×200.

FIGURE 173. Raspberry jam, lead iodide reaction on a slide. ×5.

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A B C D E

FIGURE 174. Lead iodide reaction in filtered jams. (A) apple, (B) apple and gooseberry, (C) gooseberry, (D) logan, and (E) raspberry.

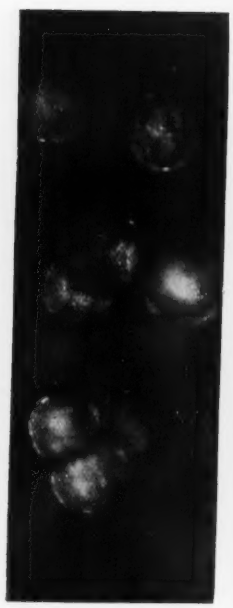

FIGURE 175. Apple.

FIGURE 176. Gooseberry with apple.

FIGURE 177. Gooseberry.

Lead iodide aggregates from test tubes. × 100.

can be traced in the apple and gooseberry mixture. Stratification is visible in loganberry, whilst in raspberry it is strongly marked, and the interspaces are unusually clear. Visual examination of the test tubes is secondary in importance to a microscopical examination of the deposits.

The largest aggregates are found low down in the tube in the interspaces, the layers being composed of small bodies closely packed. To obtain the large aggregates undamaged, I break the tube: suitable portions are then taken with a knife, and mounted in a thin tin cell, using the jelly as a medium. The cell is fastened to the slip with marine glue, and a coating of the same cement is applied to the upper surface of the cell; a drop of the jelly containing the aggregates is placed in the cell, and a cover-glass on top of it. The slip is then held, face downwards, over a spirit lamp until the moisture, which condenses on the glass in a cloud, has just cleared, when the slide is sealed by pressing it, face down, against a piece of tissue paper placed on a flat surface, such as a sheet of glass.

For the microscopical examination of these slides, I find nothing better than a one-inch objective and a Lieberkuhn. The aggregates are too opaque to be viewed by transmitted light, only their outlines being apparent, but dark-ground illumination is quite feasible. Aggregates of lead iodide formed in fruit jellies are shown in Figures 175–177. The specimens were obtained from the first three tubes in Figure 174. Apple shows rounded groups of smaller spheres. In gooseberry the groups are more irregular, generally three- or four-lobed, and seem to be built up of flat discs. In apple and gooseberry the nodules are intermediate, but I cannot claim that they have marked characteristics: they seem, perhaps, more to favour the apple type.

In colloid bodies, such as gelatine, agar-agar, or starch gels, the lead iodide reäction in test tubes is not long in reaching the stage when the results can be usefully examined—a week will generally suffice—but the addition or presence of sugar inconveniently delays matters. A fruit jelly may take six or eight weeks before it is ripe for examination. It occurred to me that by carrying out the tests in microscope slides a complete record of all stages of the reäction might be obtained in a convenient shape. Upon experimenting in this direction it was found that this plan gave results in a few hours, instead of days or weeks, though I am afraid that the aggregates in the confined space of a microscope slide cannot assume such characteristic forms as those grown without restriction.

The jelly to be tested is prepared in the same way as for tube tests. I generally employ the small surplus left after filling the test tubes for making three or four slides. A drop of the jelly is placed on the centre of a clean slip, and a thin three-quarter-inch cover-glass is placed upon the jelly. The slip is next held over a spirit lamp until the jelly begins to boil. The slip is then placed on the table, and the cover-glass pressed down with a five-eighth-inch cork, and held until all bubbling has ceased, and the slide has cooled. The preparation should now be transparent and free from bubbles, and with a surplus ring of jelly round the outside of the cover-glass. After a fifteen or thirty minutes' rest, the slide is placed in a bath of ten per cent. lead nitrate. The surplus unprotected jelly turns yellow at once, and gradually the formation of lead iodide proceeds inwards under the cover-glass. If all goes well, the action proceeds with perfect regularity, and may be stopped in about eighteen hours. It is undesirable to leave a slide in the bath too long, as it is more difficult to seal up afterwards. There should be a circular area in the middle of the slide, of about one-eighth of an inch in diameter, free from the yellow deposit. Figure 173 is a particularly fine example. Sometimes irregular action takes place (in tubes as well as slides); instead of concentric markings, we get opaque masses and broken curves. Tender jellies, such as strawberry, are prone to give trouble in this way. Two preventive measures may be taken: enough jelly should be put on the slip at the outset to ensure a surplus all round the cover-glass (too much is messy, but does no harm, too little is likely to cause trouble); or, secondly, the jelly may be taken to a higher temperature. A pure strawberry jam would require boiling to 230°, whilst an "improved" jam, containing gooseberry or apple, gives no trouble at 225°. The boiling-point of a jam containing agar-agar is lower still.

When the reäction in the slide has proceeded far enough, the slide is taken out of the bath, its surplus jelly carefully removed with a brush, rinsed in distilled water, and dried quickly. It is then promptly ringed with old gold size on a turntable, great care being taken to avoid touching the cover glass with the brush, whilst the size must flow right up to and embrace the edge of the cover. When the size is dry another coat should be applied, this time going over the edge of the cover. A coat or two of enamel and a final application of gold size will make the mount firm enough to clean without damage to the preparation. Care must be used, as pressure on the cover-glass will break the larger aggregates, especially when they are spherical in form, as in the case of pure raspberry. A slide of raspberry jam prepared in this way is shown, slightly magnified, in Figure 167. For making records of complete slides I use a two-inch Aldis photomicrographic lens in the camera.

Here, as with test tubes, the larger particles are found in the interspaces. The aggregates in slides are, however, so thin that they can be examined in the microscope by transmitted light, or, in fact, any other method of illumination. The formations are minute, and require a higher magnification to record them. Our illustrations record tests of raspberry jams, one pure and two adulterated. The first, Figure 167, is a pure jam: the layers are strongly marked, and larger individual

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aggregates are rounded and opaque. Figure 172 is a raspberry and apple jam (otherwise an "improved" raspberry jam), and twenty-five per cent. of the fruit content is apple juice. The jam is so well prepared that the microscope alone does not reveal the adulterant. Here the layers consist of a cloud of minute particles, whilst the aggregates are translucent discs; only here and there can the opaque form be discovered. Lastly, in Figure 171, we have a raspberry jam with a minute trace of agar-agar, one part in five hundred. The formation of layers, though discernible under the microscope, is barely noticeable in the small area reproduced, whilst the appearance of the aggregates is different from the other examples.

It is necessary to bring considerable experience to the interpretation of the tests outlined above; even then it is improbable that small percentages of adulterants could be detected and accurately determined without far more care and attention than I have been able to bestow upon these investigations. If, however, it is possible by this means to detect large admixtures of filtered jellies, an important advance in the analysis of jams has been made. It is confessedly impossible to-day to tell whether or not a red currant jelly is pure; if filtration has been thorough the microscope reveals nothing, and the analyst can only report that he finds no evidence of the introduction of other fruit. Colloidal investigations should indicate the presence of gooseberry or apple in most commercial jellies.

It is desirable that other reäctions should receive careful attention; it is conceivable that a certain reäction may give particularly characteristic aggregates with one jelly, and so lead to its easy detection as an adulterant.

SOLAR DISTURBANCES DURING MARCH, 1914.

By FRANK C. DENNETT.

MARCH, notwithstanding the great amount of cloud and wet, has proved of interest to the solar observer. Four days (4th, 5th, 8th, and 13th) were missed altogether. On nine (1st, to 3rd, 7th, 9th, 19th, 20th, 25th, and 26th) the disc appeared free from disturbance, bright or dark; nine others yielded faculae, and spots were present on the remaining nine. The central meridian at noon on March 1st was 171° 43′. From the high latitude of one disturbance it has been found necessary to widen the chart this month.

No. 2.—Two pores, the larger preceding, and having a faculic edge, the other amid a faculic cloud. First seen March 12th, advancing from the north-eastern limb, the leader about four thousand miles in diameter. One of the pores, very small, continued until the 16th.

No. 3.—Interesting from its high northern latitude. Broke out on the 15th, a small spot with one pore just in front, and another behind it, whilst two more spotlets were at the rear, making the disturbance thirty-seven thousand miles in length. On the 16th and 17th the eastern spot was much the largest, being about seven thousand miles in diameter. When last seen, on the 18th, another smaller spot had opened in the rear of the large spot.

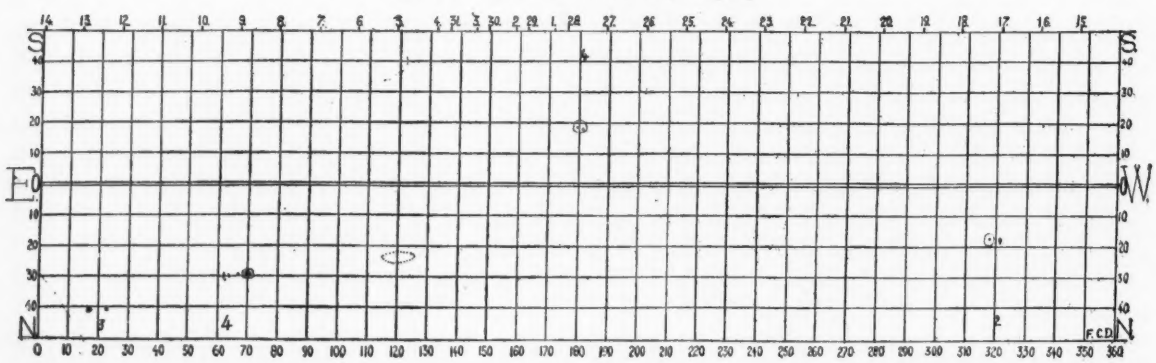
No. 4.—Two pores in a faculic area in southern latitude, near the south-eastern limb; seen only on March 22nd.

No. 5.—The finest disturbance since 1910. On 30th a spot, twenty-five thousand miles in diameter, was visible close to the north-eastern limb. Next day several smaller spots had come into view in its rear, and a bright tongue penetrated into its umbra from the north. Not much change was seen on April 1st; but on the 2nd the great spot had become doubled, and on the 3rd had split apart, the distance widening until the group, on the 6th, was composed of a leader, with bright-bridged umbra, 12,500 miles in diameter, and a rear spot with two larger and some smaller umbrae, twenty-five thousand miles in diameter, and penumbral streaks with small umbrae between, the whole sixty-eight thousand miles in length. Subsequently, the rear spot broke up, and the individual members of the group seemed dwindling as they approached the limb, round which it was lost on April 12th, a small spotlet being visible amid faculic disturbance.

Faculae were visible near the eastern limb on March 6th, and near the South Pole on the 10th and 11th, and also on the later date north-east, a disturbance amid which No. 2 broke out. Faculae were visible near the south-eastern limb on 21st, 23rd, and 24th. On March 27th to 29th a fine faculic area was near the north-eastern limb, shown around longitude 120° on the chart, and on the 29th some faculae also visible in the south-west.

Our chart is constructed from the combined observations of Messrs. J. McHaig, A. A. Buss, J. C. Simpson, E. E. Peacock, and the writer.

DAY OF MARCH, 1914.



METEORS.

By THE REV. M. DAVIDSON, B.A., B.Sc., F.R.A.S.

THE study of meteoric phenomena is an interesting one, offering to the amateur an introduction to more important work in other branches of astronomy. On any clear night a watch conducted for only a short period is certain to be rewarded by the appearance of a number of meteors, darting about in different parts of the heavens and in various directions. If the observer be fortunate enough to possess a celestial globe, he will find it useful to trace out their apparent paths in a backward sense; that is, by drawing with a soft pencil great circles on the globe from the *beginning* of the path in a direction *away from* the end. If a globe be not available, a star-chart may be used, but is not so valuable in the results.

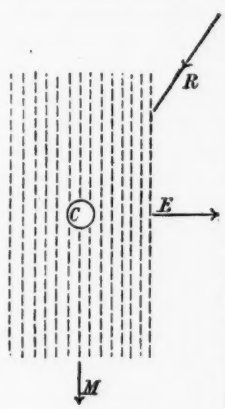


FIGURE 178.

Should the meteors observed belong to a definite shower, say the Lyrids, it will be noticed that the paths traced backwards appear to converge into a small area, to which the name "radiant" is applied. If they belong to no definite shower, but are "sporadic"—that is, coming from various parts of the celestial sphere, and quite unconnected—no such convergence is noticeable, the lines pencilled out showing no tendency to meet in a point or a small area. In what follows we shall try to show the difference between these types of meteors, and also the reason why the paths traced backwards converge towards the "radiant" in the case of the definite showers.

If we consider a meteor stream—say the Lyrids, Perseids, Leonids, and so on—we must remember that the width may be many millions of miles, and that the Earth, moving above a million and a half miles a day, would remain in the stream for several days, or, as in the case of the Perseids, much longer. Referring to Figure 178 this will be more clearly understood. The vertical lines represent the paths of the myriads of meteoric particles: each separate particle is shown by the short lines into which the longer ones are divided. The fourteen vertical lines are parallel, and approximately represent the manner in which the meteor streams pursue their paths through space, moving in orbits around the Sun, the different particles at any portion of the orbit moving in nearly parallel directions. The Earth is moving in the direction indicated by the horizontal arrow, so that there are two velocities to consider: (*a*) The velocity of the meteor stream in the direction marked M; (*b*) the velocity of the Earth. By combining these two, the velocity of the meteor particles being about $\sqrt{2}$ that of the Earth, the actual direction from which the meteors appear to come is that of the line marked R: this is their direction relative to the Earth, and the prolongation of this line backwards to meet the celestial sphere determines the radiant.

In Figure 180, let C_1, C_2, C_3, C_4, be layers of atmosphere at various heights, and P an observer on the surface of the Earth, denoted by a circle whose centre is C. Take BACF to be the celestial sphere, and assume that the plane of the paper represents a plane through the centre of the Earth and the observer, intersecting the meteor stream in the parallel lines aa′, bb′, cc′. We assume that these last three lines represent the *relative* motion of the meteor particles, that is, the motion obtained by combining the velocities of the Earth and the meteors. The atmospheric dimensions are considerably exaggerated, so that the results may be seen more clearly.

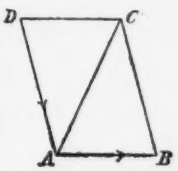


FIGURE 179.

Now consider a particle moving in the direction aa′ relative to the Earth, its appearance being at a, where it encounters the layer C_1, and its end being at a′ in the layer C_2. An observer at P sees its path projected on the celestial sphere, and its apparent path is AA′. The other particles bb′ and cc′ can be similarly treated, the observer seeing them apparently moving along portions of the celestial sphere BB′, CC′ respectively, the assumption being that they become luminous at b and c, and disappear at b′ and c′ respectively. We may remark in passing that the heights at which meteors appear and disappear are very various, so that the reader will see the justification for taking different atmospheric layers into consideration.

At first sight there appears to be little connection between the paths AA′, BB′, and CC′, but these paths produced backwards converge to the radiant marked R in the figure. It is easy to see what is implied by the radiant. The three parallel lines

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a'a, b'b, and c'c, if produced to infinity, meet at a point R on the celestial sphere, and it is from this point that the streams of meteors, moving in parallel lines, appear to come. The fact that we know the velocity of a meteor with reference to the velocity of the Earth, and also the resultant direction obtained by combining the two, gives us the first step in finding the orbit of a meteor stream (on which we hope to say something in a future article). Thus, by referring to Figure 178, if we know the direction of the line R, which is the direction of the resultant velocity, and also the ratio between

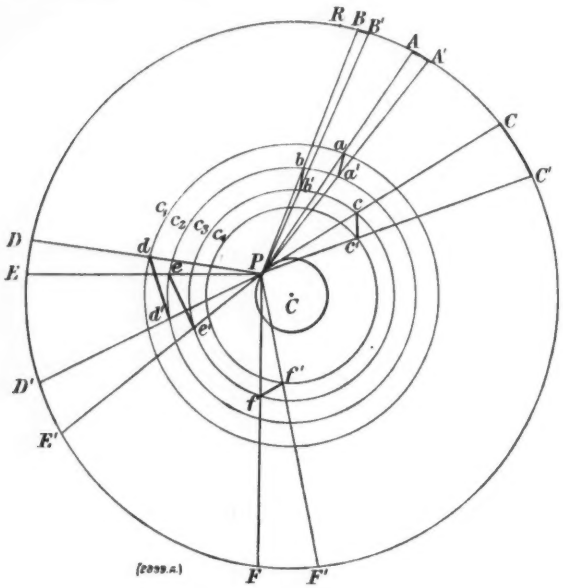

FIGURE 180.

the velocities of the Earth and the meteors, generally about 1 : $\sqrt{2}$, we can at once determine the true direction, M, of the motion of the stream, since we know the point towards which the Earth is moving at the time. The determination of the direction of M gives us the tangent to the meteor stream at the point of intersection of the Earth's orbit, and from this it is possible to find the elements of the orbit of the meteor stream.

Now let us consider the relative paths of three other particles which are not connected with any definite stream, such as dd', ee', ff'. Using the same reasoning as before, an observer at P would see their apparent paths along the portions of the celestial sphere marked DD', EE', FF' respectively. In this case these arcs will not meet in a point, as there is no definite radiant, the meteors being known as "sporadic." We have represented the phenomena of meteor motion in one plane for the sake of simplicity, but it is easily seen how the argument would apply if the atmospheric strata and the heavens be taken, as they should be, not as circles, but as concentric spheres. Those who possess a celestial globe can follow the reasoning more easily by imagining an observer at the centre of the globe, atmospheric layers arranged in small spheres around him, and the apparent paths of a meteor shower traced upon the surface of the globe which represents the celestial sphere.

We may refer to Figure 180 for an explanation of the fact that long-pathed meteors are generally far from the radiant, and that short-pathed meteors are, as a rule, near the radiant. Consider the flight bb': its projection, BB', is rather a short path; the projection of aa' is longer, and that of cc' longer still, although the actual lengths of the paths aa', bb', cc', are nearly the same. It is easy to see that the closer a meteor is to the radiant the shorter is its path, and, indeed, if a meteor is seen to be stationary, appearing like a flash, but without moving over any arc on the celestial sphere, we know that its radiant is where it appears. Thus, if a meteor belonging to the shower which we are considering appeared at R as a flash, we should feel justified in saying that its motion was in a direction from R to P, where P still represents the observer, and also that R was its radiant. A familiar instance will explain this more fully. Suppose on some night that the lights of a motor-car are observed at a distance of, say, one mile, and that the motor-car is moving athwart our line of sight. There would be no difficulty in recognising the motion; we should simply refer the lights of the car to some stationary objects, say street lamps in the distance. But if the car is coming straight towards us, we should not easily recognise that it was moving; the lights might appear to be stationary. The slightest deviation from the line drawn between the observer and the car would be noticed after a time, and the greater this deviation, the faster is the apparent motion of the car.

This illustration will make clear the fact that a meteor may have quite a long path in the atmosphere, and yet its apparent path may be very much shortened, or it may appear like a flash, if it is moving nearly in a line towards the observer.

Having determined the radiant, the relative velocity with which the meteors enter our atmosphere can be easily found. First of all, we must know to what part of the heavens the Earth is moving at the time. This is easily found when we remember that the orbit of the Earth is nearly circular, and therefore the direction of the motion at any instant is very nearly perpendicular to the line joining the Earth and the Sun. If we deduct 90° from the longitude of the Sun, we obtain the point on the ecliptic towards which the Earth is moving at the instant: this point is known as the "Apex of the Earth's Way." Although this method does not give it exactly, nevertheless it is approximate enough for the present purpose, the error never amounting to 1°. Knowing the direction of the Earth's motion and the apparent

direction of motion of the meteor stream, denoted by R in Figure 178, we can easily find the true direction, M, of the meteor stream by means of the parallelogram of velocities. The angle ECR is known as the apparent elongation of the radiant from the apex of the Earth's way, and the first step is to find its value. The following simple formula will be found useful for this purpose, and can be easily applied by the general reader :—

If l be the longitude and b the latitude of the radiant, A the longitude of the apex of the Earth's way and ϵ the apparent elongation of the radiant from the apex of the Earth's way,

$$\cos \epsilon = \cos b \cos(l - A).$$

Thus, if the longitude of the Sun is 166°·8, we may take A to be 76°·8. If l=131°·5, and b=23°, we have $\cos \epsilon = \cos 23° \cos 54°{\cdot}7$, or ϵ=57°·9. It should be noticed that ϵ can have all values from 0° to 180°, and that attention must be given to the sign on the right side of the equation. Thus, if A=106°, l=305°, b=3°·5, then l−A=199°, and $\cos \epsilon = \cos 3°{\cdot}5 \cos 199° = -{\cdot}9437$.

$$\therefore \epsilon = 180 - 19°{\cdot}3 = 160°{\cdot}7.$$

In Figure 179 let AB represent the velocity of the

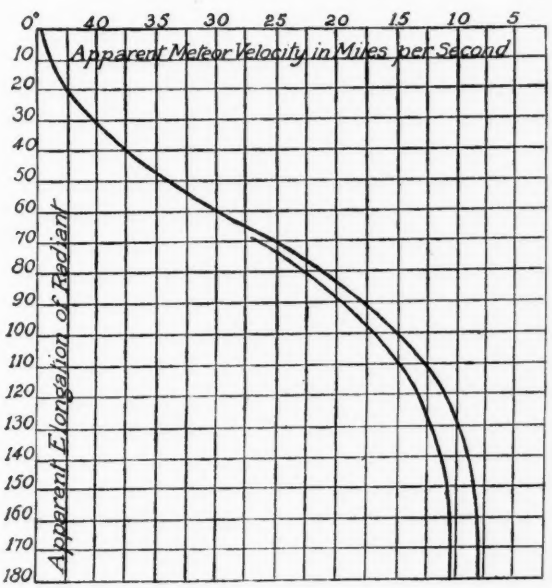
0° 40 35 30 25 20 15 10 5
Apparent Meteor Velocity in Miles per Second
10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180
Apparent Elongation of Radiant

FIGURE 181.

Earth in magnitude and direction, and DA that of the meteor in magnitude and direction. Complete the parallelogram and join CA. This line will represent the velocity of the meteor, relative to the Earth, in magnitude and direction.

The angle CAB is the apparent elongation of the radiant, which we denote by ϵ. Let the angle DAB be ϵ'; then $\frac{CA}{AB} = \frac{\sin CBA}{\sin ACB} = \frac{\sin \epsilon'}{\sin (\epsilon' - \epsilon)}$

or $$CA = AB \frac{\sin \epsilon'}{\sin (\epsilon' - \epsilon)}.$$

Now, in the case of meteor streams, we assume that they are moving around the Sun with parabolic velocity, so that the velocity of the meteors is $\sqrt{2}$, if that of the Earth is 1. From the triangle CAB, $\frac{AB}{BC} = \frac{\sin (\epsilon' - \epsilon)}{\sin \epsilon}$, or $\sin (\epsilon' - \epsilon) = \frac{1}{\sqrt{2}} \sin \epsilon$, from which $\epsilon' - \epsilon$, and therefore ϵ' can be found.

Hence, $CA = AB . \frac{\sqrt{2} \sin \epsilon'}{\sin \epsilon}$. As AB represents the orbital velocity of the Earth, about 18·47 miles a second, the relative velocity with which a meteor enters our atmosphere is $18{\cdot}47 \sqrt{2} \frac{\sin \epsilon'}{\sin \epsilon}$. One example will make this clear. If ϵ=63°, the equation $\sin (\epsilon' - \epsilon) = \frac{1}{\sqrt{2}} \sin \epsilon$ gives $\epsilon' - \epsilon = 39°$, or ϵ'=102°. Hence, the relative velocity of approach to the Earth is $18{\cdot}47 \sqrt{2} \frac{\sin 102°}{\sin 63°} = 28{\cdot}67$ miles a second.

The accompanying graph (see Figure 181) shows the relative velocities for various elongations of the radiant. There is another graph which gives higher velocities: this latter is constructed by allowing for the increased velocity of a meteor caused by the attraction of the Earth. For low velocities the two differ by nearly three miles, but as the velocities increase this difference becomes smaller, until an elongation of 0° is reached, when the difference is a little over half a mile. The increased velocity V, say, can be found from the unaccelerated velocity, v, by the formula $V2 = v2 + 49$. The graphs explain themselves. Thus, for an apparent elongation of 130°, the accelerated velocity reads just under 12·5, and the unaccelerated velocity 10 miles a second. The graph for the higher velocities has not been continued beyond an apparent elongation of 70°, as the two curves would approach very closely, so that it would be difficult to distinguish between them.

Figures 178 to 180 are reproduced by kind permission of the Council of the British Astronomical Association.

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NOTES.

ASTRONOMY.

By A. C. D. Crommelin, B.A., D.Sc., F.R.A.S.

MARS.—*Popular Astronomy* for recent months has contained an interesting series of articles on Mars by Professor W. H. Pickering, who has been in charge of an expedition from Harvard College to Mandeville, Jamaica (altitude, two thousand one hundred feet) to observe the recent apparition with an eleven-inch Clark refractor. He refers to the enormous scale on which inundation from snow-melting takes place in Siberia, where vast tracts are converted into semi-lakes, and thinks that the appearances round the melting Martian snow-caps can be explained by a similar phenomenon.

Observations were begun on July 27th, over five months before opposition. No snow was then visible on the disc, the south polar regions being reddish and free from snow or cloud. The North Pole was 10° below the horizon, but the edge of the cloud-cap surrounding it could be seen. Snow was seen in September round both poles, the northern cap being two thousand three hundred miles across. On August 14th there was an unusual amount of cloud on the disc, four-tenths of it being covered.

The dark zone surrounding the northern snow became visible, and afterwards the darkening extended to Ganges and Aurorae Sinus, suggesting, according to Professor Pickering, the transference of moisture.

On October 19th it is noted that Solis Lacus and Lacus Phoenicis were invisible, though near the central meridian. It is distinctly noted that the dark band round the north polar cap was not visible when the snow was first seen, but increased rapidly in intensity. It was irregular in width, being chiefly concentrated in four knots, one of which found the head of the Canal Amenthes; another was the Acidalium Mare. A broad, dark band reached from this to the Equator. Great changes of shape could be detected in some of the well-known markings. Thus the zero meridian, Fastigium Aryn, could not be distinguished at the end of 1913, the two bays running together and forming a semi-circular knob corresponding to the aspect in a drawing by Beer and Mädler in 1830. Sabaeus Sinus and Margaritifer Sinus were observed to grow towards the north at the rate of four miles per hour. They were of a different tone from Mare Acidalium, which was blue, and is supposed to have been a plain covered with shallow water.

Two bays, resembling Margaritifer, developed suddenly about December 16th in longitudes 185° and 160°. Measures of the polar cap indicate that, when melting, its edge retreated one hundred miles per day. This indicates that the layer of snow or ice is thin, but not a mere film of hoar-frost, since that would disappear simultaneously over immense areas, and not show a definite retreat. A layer of snow, of gradually increasing thickness, seems to be indicated.

The north polar cap attained its greatest development on November 2nd, "corresponding to the equivalent date of March 5th of the terrestrial year," when its boundary lay in latitude 57° on the average, but extended to 42° in some parts. The dark band round the cap reached its maximum breadth of 25° in the first half of November.

The general result of the report is to increase our estimate of the prevalence of cloud on the planet, and to make it probable that a considerable amount of moisture is precipitated as rain or snow. Also some of the well-known outlines of the planet are shown to be subject to large fluctuations, partly arising from obscuration by cloud, but partly of a real objective character.

Both Professors Pickering and Lowell have found that the zero meridian (Fastigium Aryn) passes the centre of the disc ten or twelve minutes before the time given in the Almanac. The latter uses the period of rotation $24^h\,37^m\,22^s{\cdot}65$, and the time of passage of the zero meridian was adjusted about 1894 to agree with Lowell's observations.

Hence the error of the adopted period would be 10^m in twenty years, or $\frac{1}{2}^m$ per year, or $^s{\cdot}08$ per rotation, which would make $24^h\,37^m\,22^s{\cdot}57$. It will be remembered that Kaiser found $22^s{\cdot}62$ for the seconds, but Proctor pointed out some numerical mistakes in his work. In spite of these Kaiser's result appears to be nearer the truth than that of Proctor, who found $22^s{\cdot}72$ for the seconds. Kaiser's value was confirmed by Marth, who worked from Maraldi's drawings of 1704, and found $22^s{\cdot}626$. It seems to me that both Kaiser and Proctor exaggerated the accuracy of the very rough drawings of the seventeenth century. It is a truism that an equally good rotation period can be derived from an interval one-quarter of the length used by Proctor provided that the accuracy of the drawing is four times as great. I question whether it is wise to go further back than the numerous drawings of Sir W. Herschel, made in 1783. It would be a good piece of work for anyone with the necessary leisure to rediscuss these drawings, combined with accurately timed modern ones, and deduce a new rotation period. Even a shorter interval might yield useful results. Half a century has now passed since the beautiful and accurate drawings of Rev. W. R. Dawes were made. However, what is required for this purpose is not an elaborate drawing of the whole visible disc, which must take a considerable time to execute, so that one is doubtful whether the time affixed to the drawing is that corresponding to the execution of the particular feature discussed. What would be of more value would be a note of the passage of some well-known feature over the central meridian, but unfortunately such observations are exceedingly scanty. Let observers put a considerable number of them on record, so that they may be utilised in coming years.

COMETS.—The interesting comet of Delavan was observed in March, but by the time these notes appear it will be lost in the Sun's rays, to reappear in July in the morning sky, when it should be much brighter.

The first comet of 1914 was discovered by Herr Kritzinger of Bothkamp on March 29th. The following orbit is by Dr. Kobold from observations on March 29th, 30th, and 31st:—

$T = 1914$, May 31·14 G.M.T.
$\omega = 67°\ 1'$.
$\Omega = 198°\ 37'$.
$i = 23°\ 31'$.
Log. $q = 0{\cdot}0991$.

Ephemeris for 11 p.m.

	R.A.	N.Dec.	Log r.	Log Δ
May 6	$18^h\,31^m\,14^s$ ...	20° 49′ ...	0·1178 ...	9·7130
,, 14	19 3 26 ...	27 27 ...	0·1080 ...	9·7154
,, 22	19 34 56 ...	32 55 ...	0·1015 ...	9·7275
,, 30	20 5 26 ...	37 13 ...	0·0992 ...	9·7456

The comet will be due south during May, about 3 a.m., and will be readily observable before midnight. It should be a conspicuous telescopic object when the Moon is absent. It is nearest the Earth on May 9th, the distance being 0·5154 in astronomical units.

THE NAUTICAL ALMANAC FOR 1916.—The chief feature of present interest in this volume, which has just been issued, is the path of the shadow in the total solar eclipse of February 3rd. The shadow will not fall on any

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part of the Azores, but passes some seven miles to the north-west of Corvo. Those who wish to see the eclipse from land will have to go to Guadaloupe, or South America (north coast). It is noteworthy that the shadow track passes nearer our shores than has been the case for a long time. A voyage of one hundred and fifty miles west of the Scilly Isles will suffice to see the sun set totally eclipsed; it will, however, be necessary to go several hundred miles further west to obtain a sufficiently high Sun to permit a view of the corona. It is likely that several Atlantic liners may slightly modify their course so as to come within the shadow track.

BOTANY.

By PROFESSOR F. CAVERS, D.Sc., F.L.S.

THE PURPLE SULPHUR-BACTERIA.—M. Skene (*New Phytologist*, 1914) has made an investigation of some members of the remarkable group of Schizomycetes included under the name "sulphur bacteria." These bacteria are capable of oxidising sulphur or one of its unoxidised compounds, producing in some cases sulphur, and in others sulphuric acid, and they are divided into two main series. To the first series belong those which resemble ordinary bacteria in form, and do not store up sulphur internally; such are the Thiobacilli, which oxidise thiosulphates to sulphur or sulphuric acid, and thus obtain energy which they expend on the reduction of carbon dioxide; hence they are "autotrophic" in the sense that they do not, like most bacteria, require carbon in an organic form. The second series includes a number of forms which oxidise sulphuretted hydrogen to sulphuric acid. The process takes place in two stages, sulphur being first formed and stored inside the cells as globular masses, which are then further oxidised. Of the sulphur-storing forms there are two kinds: (1) Colourless forms like *Beggiatoa* and *Thiothrix*, which have been recently shown to be autotrophic; and (2) forms possessing a red pigment, the so-called purple sulphur bacteria, with which Skene's paper is specially concerned.

These forms (*Chromatium, Lamprocystis, Amoebobacter, Thiopolycoccus, Thiothece*) occur in stagnant water, and, though not very common, they sometimes occur in such masses as to colour the water or mud bright-red or purplish; hence they have been frequently investigated. The writer, who worked chiefly with *Amoebobacter roseus* and *Lamprocystis roseo-persicina*, gives details of his methods of culture, compares his results with those of earlier observers, and summarises his work as follows: The attempts made to obtain pure cultures of purple sulphur bacteria were without success. In mixed cultures *Amoebobacter* (and probably also *Lamprocystis*) thrives best in a mineral solution containing ammonium sulphate as a source of nitrogen, and with chalk as a neutralising agent. All the organic sources of nitrogen and carbon which were investigated proved to be without favourable influence on the growth of the bacteria; indeed, as a rule, they tend to inhibit development. Development can only take place in the presence of hydrogen sulphide, which cannot be replaced by other sulphur compounds. Growth takes place only in light, red light being more effective than blue. The purple sulphur bacteria require free oxygen, which is probably supplied in nature by associated green organisms.

THE ORIGIN OF FLOWERING PLANTS.—In a paper on the development of the stamens, ovules, and embryo of the Magnoliaceae, Maneval (*Bot. Gaz.*, 1914) brings together a very useful summary of the various theories that have been put forward regarding the origin of the higher flowering plants, or Angiosperms. After pointing out the general agreement among botanists that the Dicotyledons are more primitive than, and have given rise to, the Monocotyledons, he considers the question of the primitiveness of various features among the Dicotyledons themselves. The present theories are fairly represented by the views of Wettstein on the one hand and those of Arber and Parkin on the other. Both theories agree in deriving Angiosperms from Gymnosperms, and Monocotyledons from Dicotyledons. Wettstein considers that the following are primitive characters for Angiosperms: Prevalence of woody plants and absence of vessels in the vascular bundles; prevalence of unisexual flowers, with either no perianth (sepals or petals) or one of simple structure; prevalence of anemophily (wind-pollination). These are Gymnosperm characters; hence Wettstein holds that we should regard that group of Angiosperms as most primitive which shows these characters developed in a high degree. Arber and Parkin give a longer list of characters which they believe are primitive: on their view, regular and bisexual flowers, entomophilous (insect-pollinated), with an elongated axis bearing a well-developed petaloid perianth and numerous free spirally arranged stamens and carpels, are primitive. If it be granted that all the essential characters that can be regarded as primitive are included in these lists, then it is evident that the chief differences between the two theories relate to but a few points—points, however, which involve no end of difficulty. The two theories would practically be reduced to one if we could say which of the following are primitive, unisexual or bisexual flowers, presence or absence of a perianth, anemophily or entomophily. The fact that certain characters are common to all or nearly all Gymnosperms seems in many instances to be one of the strongest reasons for regarding these characters as primitive if they occur at all among Angiosperms. Among such supposedly primitive characters are dicotyledony of the embryo, prevalence of woody plants, and absence of true vessels (tracheae) from the conducting strands. For the same reason we might conclude that primitive Angiosperms were wind-pollinated, and possessed naked and unisexual flowers, since these characters also are common to most Gymnosperms. The striking resemblances in the essential organs of reproduction in Monocotyledons and Dicotyledons—particularly in such structures as the embryo-sac—makes it almost inconceivable that the two groups have had a separate origin, while the essential similarity in vegetative structure of all Dicotyledons (the important differences being merely in form and arrangement of the leaves and non-essential floral organs) makes it equally likely that this group arose from a single stock. If this be granted the questions arise: "Which Dicotyledons are the most primitive?" and "From what particular stock of Gymnosperms have they come?" As regards the latter question, the Gnetales, and more recently the extinct Bennettitales, have been regarded as the source of the Angiosperms; but opinions differ as to which is the parent group, according to whether one regards naked unisexual anemophilous flowers, or entomophilous bisexual ones with a perianth, as primitive. Insect-pollination is clearly associated with much of the evolution of Angiosperms, but it does not necessarily follow that primitive Angiosperms were entomophilous. That anemophilous Angiosperms may succeed and persist in competition with entomophilous forms is well illustrated by such groups as the grasses and the catkin-bearing trees.

Few botanists believe that the flower of any existing Angiosperm is like the primitive Angiospermous flower; whether the latter was unisexual or bisexual it does not follow, though this is quite possible, that any particular flower of to-day is the direct descendant of a similar type in its ancestor. It is certain that in many instances bisexual flowers have become unisexual, and that perianths have been more or less completely lost. That the opposite may have occurred is less easily proved. Whatever view is taken, the origin of the perianth remains at present a mystery, and it may have been developed among Angiosperms long after they had become a distinct group of plants. The question whether primitive Angiosperms had unisexual or bisexual flowers presents quite as great difficulties as that concerning the primitiveness of the perianth. Evidence from Gymnosperms that bisexual flowers are primitive rests almost

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entirely on a single extinct and much specialised group, the Bennettitales, which many regard as representing the end of a distinct line of Gymnosperm development. The resemblance of the Bennettites cone to a flower like that of Magnolia is remarkable, but it has been suggested that the Bennettites " flower " is really an inflorescence, or group of flowers, and if the Magnolia flower is not compound the resemblance becomes only a superficial one.

Although bisexual flowers occur in *Welwitschia*, one of the Gnetales—which have in some respects developed along parallel lines with the Angiosperms, *e.g.*, in having true vessels—the Gnetales can hardly be regarded as actual transition forms leading to Angiosperms, though this does not preclude the possibility of common ancestry in the distant past. The Gnetales most likely represent the end of a Gymnosperm line just as the Bennettitales do; hence neither group represents the direct progenitors of Angiosperms.

All these considerations point to the conclusion that the ancestors of the Angiosperms in the remote past had naked unisexual flowers, but that among existing groups, bisexual flowers with a perianth are primitive, the naked unisexual forms (*e.g.*, the catkin-bearing families, or Amentiferae) having been secondarily derived from the latter: these forms, often considered as primitive, frequently have complex inflorescences; the ovary is prevailingly syncarpous, and there are other features that are certainly to be regarded as derived and not primitive.

The author is therefore led to conclude that the type of flower found in Magnoliaceae is the most primitive to be found in existing Angiosperms; that the Bennettitales, Gnetales, and Angiosperms may have had common ancestors if we go back to a time prior to that when the Bennettitales became a distinct line; and that Angiosperms were probably either derived from the same ancient fern stock from which the Cycadofilicales originated or were differentiated from that group at a very early time.

A HETEROSPOROUS FOSSIL FERN.—Lignier (*Mém. Soc. Linn. Normandie*, 1913) has described a new genus (*Mittagia*) from the Lower Westphalian strata, which is the first heterosporous fossil fern so far discovered. That such forms probably occurred might, of course, be expected from the existence in the Palaeozoic of the remarkable group Cycadofilicales (or Pteridosperms), which combine the characters of ferns and of seed-plants; but this is the first demonstration of their presence. Lignier at first thought his sections were those of the well-known Pteridosperm, *Lagenostoma Lomaxi*, the outer tissues of the sporangium being similar; but he found four megaspores to a sporangium, a stomium like that characteristic of fern sporangia, and the latter in a sorus, these features showing clearly that his plant was something very different from a Pteridosperm. Apparently the sporangium did not open, and thus represented a stage towards the seed habit. The author shows how this new fossil differs from anything hitherto found among the Equisetales, Lycopodiales, and Cycadofilicales, and his discovery appears to be one of the most interesting and important made in fossil botany for many years.

DIASTASE IN RED ALGAE.—In the Red Algae grains resembling in form, and probably in general composition, the starch grains of green plants are formed, though apparently they are not deposited in the plastids as in most starch-forming plants, but in the protoplasm outside the plastids, and often apparently quite independent of them. These grains in the Red Algae do not give the usual blue colour when treated with iodine, the colour in some cases being violet, but usually ranging from light brown to wine-red; indeed, so wide is the colour range that possibly each species will be found to give its own characteristic colour reäction with iodine. Various investigators have shown that these grains differ from ordinary starch further in resisting the action of malt extract, while the sugars they give on being treated with acids—galactose and fructose, besides glucose—differ from those yielded by ordinary starch. Since, however, the grains appear and disappear at various times during the life of the plant, it seems likely that, as in other plants, there is a ferment which brings about that decomposition. Bartholomew (*Bot. Gaz.*, 1914) has investigated the matter thoroughly, and has found that the Red Algae examined possess a diastase which is capable of digesting the starch of higher plants, but that the diastase of the Red Algae is probably not composed of a single ferment, but of a series of ferments (amylases which act on starches and dextrinases which act on dextrin); that, judging by the action of the algal extract upon corn starch, the diastase is a rather slow-working ferment; and that the series of digestion processes resulting from the application of the algal diastase to corn starch indicates that the substance composing the grains of the Red Algae is, after all, very similar to that of the starch grains of higher plants.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (OXON), F.I.C.

PHENOMENA SHOWN BY ACTIVE NITROGEN.—In 1911 the Hon. R. J. Strutt described an active modification of nitrogen, an account of which was given in these columns at the time. On repeating his experiments, Messrs. Tiede and Domcke (*Ber. d. d. Chem. Ges.*, 1914, XLVII, 420) found that the after-glow of the active nitrogen that had been passed over heated copper was suppressed unless oxygen had been added to the nitrogen. In the opinion of these chemists, the phosphorescence of sulphur, iodine, sodium, and other bodies which occurs when they are heated in nitrogen, through which has been passed an electric discharge, must be attributed to the presence of oxygen, and not to the nitrogen having been rendered active. On the other hand, Messrs. Koenig and Elöd (*Ber. d. d. Chem. Ges.*, 1914, XLVII, 523) have proved that the after-glow will take place in nitrogen, free from every trace of oxygen, provided that metallic vapours, such as those of mercury, are also excluded. The glow is suppressed by the presence of a mere trace of mercury vapour, such as would be derived from the pump and manometer in the experiments of Messrs Tiede and Domcke. On admitting a little oxygen, this mercury is oxidised, and the glow reäppears, while the introduction of still more oxygen extinguishes it.

The conclusions of Mr. Strutt have also been confirmed by the work of M. J. Kowalski (*Comptes Rendus*, 1914, CLVIII, 625), who has obtained the same phenomena with nitrogen from which special precautions were taken to eliminate every trace of oxygen. The orange glow of the " active nitrogen " was preceded by a series of minute explosions and an intense violet fluorescence. The explosions were attributed to the interaction of the active nitrogen upon the mercury vapour, with the formation of an explosive mercury nitride. The presence of mercury vapour (derived from the pump) in the gas was proved spectroscopically, the violet light showing the spectrum of mercury.

BLUE PERCHROMIC ACID.—The acid corresponding to potassium bichromate was believed to be present in the blue liquid obtained by treating a solution of chromic acid (chromic anhydride) with hydrogen peroxide. By shaking the solution with ether a blue layer is produced, which is more stable than the blue coloration in the aqueous liquid. Until recently, all attempts to isolate this supposed perchromic acid proved fruitless, but it has now been separated as a deep blue crystalline mass by Messrs. Riesenfeld and Mau (*Ber. d. d. Chem. Ges.*, 1914, XLVII, 548). The method employed was to dissolve chromic acid (chromic anhydride) in methyl ether, and to treat the solution with concentrated hydrogen peroxide at a temperature of $-30°$ C. The composition of the acid agreed with the formula $H_3CrO_8 . 2H_2O$, and the following constitutional formula was suggested for the compound, since the water

present appeared to be not merely water of crystallisation :

$$Cr(OH)_4(O.OH)_3.$$

The composition of the acid did not vary with the amount of hydrogen peroxide used to produce it. At temperatures higher than $-30°$ C. it decomposed, and this explains the failure of previous attempts to isolate it. Its strength as an acid was estimated to be about the same as that of acetic acid.

FERMENTATION AND THE RESPIRATION OF PLANTS.—The experiments of Dr. W. Palladin (*Biochem. Zeit.*, 1914, LX, 171) to ascertain the part played by water in the fermentation of sugar and the respiration of plants have given instructive results. It was not found possible to replace water by other solvents, such as glycerin or alcohol, without checking or inhibiting the action of the zymase (alcohol-producing enzyme) and the other enzymes of yeast. Water thus plays a part in alcoholic fermentation, and is probably the source of part, at least, of the oxygen liberated as carbon dioxide.

With regard to the respiration processes of higher plants, the conclusion is drawn that water is first assimilated, and that the oxygen required for the oxidation of the sugar (dextrose) in the plant is derived in equal proportions from this water and from the sugar itself, the whole of the carbon dioxide liberated being produced in the absence of air. The hydrogen thus set free from the water enters into combination with the respiration pigments, which are termed "hydrogen-acceptors," and the whole of the oxygen taken up by the plant in the respiration process is utilised in the oxidation of this combined hydrogen. The water formed in this oxidation is therefore of aërobic origin. This withdrawal of hydrogen from the pigment by the oxygen is effected through the agency of other enzymes, termed "peroxydases."

These views receive strong support from the experiments of Dr. Wieland upon the bacterial oxidation of alcohol into acetic acid, which pointed to the conclusion that the change was effected by oxygen derived, not from the air, but from water; while the atmospheric oxygen acted merely as an "acceptor" to combine with the hydrogen set free from the water.

ENGINEERING AND METALLURGICAL.

By T. STENHOUSE, B.Sc., A.R.S.M., F.I.C.

METALS IN WARSHIPS.—In his presidential address to the Institute of Metals Sir Henry J. Oram, Engineer-in-Chief of the Fleet, gave some interesting figures showing the proportions of non-ferrous metals and steel in the structure of the modern warship. Steel is employed wherever possible, with the result that in the newer ships there is not that wealth of copper, brass, gun-metal, and so on, which added so largely to the scrap value of the older ships. Yet, although the non-ferrous metals cannot usually compare with steel in structural strength, there are still many positions in which other qualities than strength are necessary, and in these positions the non-ferrous metals are still indispensable. Approximately for every hundred tons of iron and steel used in a modern warship there are six tons of copper or its alloys in a battleship, and eight tons in a cruiser, the difference being accounted for by the smaller proportionate amount of armour and the higher power of the cruiser. The propelling machinery of a modern battleship contains a weight of non-ferrous metals equal to seventeen per cent. of that of the contained steel and iron, while in a battleship of twenty years ago the proportion was as high as about thirty-four per cent. In the hull structure, as distinct from the propelling machinery, the proportion of non-ferrous metals shows a slight rise, being 4·4 per cent. of the iron and steel, as against 4·2 per cent. twenty years ago. Although here, also, steel has largely taken the place of non-ferrous alloys, the reduction has been counter-balanced by the considerable increase in gun-turrets and their machinery, fire-control appliances, electric lighting, telephones, and so on, where copper alloys are necessary.

LOCAL SURFACE-HARDENING OF HIGH-TENSILE STEELS.—The operation known as "case-hardening" consists in heating a mild-steel article surrounded with carbon or a suitable carbon-containing compound, so that the surface of the article becomes comparatively rich in carbon, and can be rendered very hard by quenching. Difficulties arise, however, unless the material is originally comparatively mild, and the process is not a convenient one when it is desired to harden only a relatively small portion of a given surface. Messrs. Vickers have now devised a process by which the surface of high-tensile steel may be hardened locally by simply heating the particular portion with an oxy-acetylene flame, using a welding burner, the body of the article being kept as cool as possible by immersion in water (*Engineering*, February 13th, 1914). The hottest possible flame is used, and is applied for a very short time only. Thus, in the case of a gear-wheel, the surface is traversed by the flame just as with a paint-brush. The intense heat and the rapidity with which this heat is transferred to the surface of the steel instantly cause the surface to be raised to hardening temperature. As the flame passes along, this surface is cooled by the cold remainder of the forging or casting, leaving the surface with the maximum hardness of which the steel is capable, when heated, and quenched in cold water. To obtain a thin but intensely hard surface, the part to be hardened should be just below the surface of the water, the impinging flame blowing the water away. The method involves no distortion of the mass, and does not destroy the effects of the usual heat treatment, to which the casting or forging as a whole may have been subjected.

GEOGRAPHY.

By A. STEVENS, M.A., B.Sc.

THE ECONOMIC VALUE OF TROPICAL RAINFALL.—M. G. Capus contributes an article on this subject to the *Annales de Géographie* for March last. The discussion is based on the study of the rainfall and on analyses of rain for Tonkin. The amount of nitrogen combined during thunderstorms as nitric acid and ammonia, and carried down in solution in rain, is much greater in Tonkin than in Europe. Nitrogen as nitric acid is equivalent to a mean of fifteen kilograms of sodium nitrate per hectare, and as ammonia to three to seven kilograms of ammonium sulphate. In the thirteen provinces constituting the delta of Tonkin the ground under rice must receive about seven million six hundred thousand francs' worth of chemical manure per annum, and the crops are able to use the salts to the value of about three million three hundred and twenty-five thousand francs. In Cochin China there are about one million five hundred thousand hectares under rice, and the climatic conditions are similar. In the flat land of the Tonkin delta the amount of run-off is low; accurate figures are not available, but the estimate of ten per cent. of the rainfall is adopted. Evaporation accounts for about half of the rainfall on the average, but at times considerably exceeds the actual amount of rain. The cultivated plots are in natural depressions traversed by *arroyos*, which never carry torrents of water. Rivers which are nourished by the precipitation on the mountains in the interior are often largely swollen, but the farmer sees them run, brimful of muddy water, uselessly past his parched and hardened fields. In this region, then, the engineer has splendid scope for his skill. Not only is it possible to husband the copious rainfall to supply the deficiencies of irrigation in times of drought, but the measures necessary for that will secure to the crops a superabundant supply of valuable fertilisers.

A RECENT LOWERING OF THE LEVEL OF THE CASPIAN SEA.—The same magazine contains an investigation of the fluctuations of the level of the Caspian Sea, in the period 1851–1912, by M. J. Schokalsky. There are

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oscillations of the level of the lake of three kinds: (1) oscillations of short duration, with a period of a few hours; (2) non-periodic oscillations, due to winds; (3) annual oscillations. Variations of level of the first type can be explained as the phenomenon of *seiche*. They are variable in period and amplitude, as shown in the records of the tide gauge at Bakou. The non-periodic oscillations naturally vary at a given place with variation of the direction of the wind. The annual variations of level are similar at all the stations, with minor divergences in the northern and southern extremes in amplitude, and in the times of the annual maximum and minimum.

If the monthly variations of the level of the lake are examined, it is found that in the years 1910–1913 they exceed the means calculated on the data for the previous eighteen years. This is first observed in the variation for July, 1910, and there is a continual increase thereafter. In the three years this is seen in a progressive fall in the level of the lake, amounting to 21·1, 40·2, and 43·7 centimetres in the respective years. The figures are means of values for the stations of Bakou and Kououli. The fall could easily be explained if, as has been suggested, there had been subsidence of some considerable part of the lake-floor. But a study of the volume of water delivered by the main source of water supply to the Caspian, the river Volga, makes it seem probable that no such explanation is necessary. That river receives its main confluents above Samara and Tsaritsyn, for which places data are available. The means for the three years under consideration show that the volume of water carried past these stations has decreased by amounts equivalent to mean annual falls in the level of the lake of 19·3, 25·9, 25·7 centimetres. The annual residue of the actual fall, 1·8, 14·3, 18·0 centimetres, will in all probability be accounted for by evaporation and by deficiencies in the contributions of other tributary rivers.

THE SHIFTING OF THE CLIMATIC BELTS.—Professor A. Penck, of Berlin, lectured to the Royal Scottish Geographical Society in March on the shifting of the climatic belts. Corries, similar to those at present found in countries where the land rises above the snow-line, exist at a much lower level, not only in such lands, but also in others, within and without the tropics, where there is not now perennial snow. These must have been excavated by the action of corrie glaciers, and they may be taken to indicate the former glaciation of the areas in which they are found. The ancient snow-line, as delineated by them, followed the present line where perennial snow exists with remarkable persistence and at a uniform interval of four thousand feet below it. In many regions, now arid deserts, the surfaces of the lakes are shown by ancient terraces to have stood once much higher than at present, and in such regions, also, river courses, the excavation of which cannot be assigned to spasmodic floods, are now dry. As Professor Penck reads this evidence, the Glacial epoch coincided with a time when the equatorial belt of arid deserts was much narrower than at present.

GEOGRAPHY.—Mr. B. J. S. Cahill, of San Francisco, sends a reprint of a paper describing a "new and original" projection for a land map of the world, which appeared under his name in the *Journal of the Association of Engineering Societies* (U.S.A.), October, 1913. The hemispheres are projected each in four equal quadrants, beginning at the meridian of 22½° W. The projection is conical with two (unspecified) standard parallels, but the meridians are curved inwards for about one-fifth of their length to the Pole and Equator, the Equator being straightened in each quadrant over about its middle three-fifths. The quadrants of the northern hemisphere are arranged in series with the straight parts of their bounding meridians in contact, the corresponding quadrant of the southern being connected to each by the straight part of the Equator. No method is given for the construction of the projection, and no discussion of distortion. The "mechanical demonstration," to show that an almost perfect representation of the sphere is obtained on the plane, is, of course, unsound, and the idea of a large wall map of the world folding into "regional" sections is not of any use. The author obviously does not appreciate the needs of the geographer, nor the amount of novelty or value in his production. The fact that distortion is confined mainly to the oceans does not do away with distortion, nor with its effects in rendering the map unsuited for many purposes. Mr. Cahill has received commendation from many geographers of standing, and that is a guarantee that his map, which on a small scale gives very useful ideas of the world as a whole, will suit one or two of the many purposes for which he believes it ideal.

GEOLOGY.

By G. W. TYRRELL, A.R.C.Sc., F.G.S.

MAN AND THE RATE OF EROSION.—An interesting letter, from Mr. J. Gurney Barclay, appears in "KNOWLEDGE" for March (pages 107–8), dealing with a phase of the above subject raised in one of my January Notes ("KNOWLEDGE," January, page 31), which was based on a paper by Mr. H. S. Shelton on "Some Aspects of Geological Time." It is therein argued that the rates of erosion calculated from rivers whose basins are extensively cultivated are abnormally large, because cultivation exposes the soil to denudation, and thus raises the rate of erosion. It is suggested that the normal rate of erosion, upon which datum calculations of the age of the Earth are made, should be obtained from rivers whose basins have been unaffected, or little affected, by the agency of man in cultivation. Mr. Barclay, however, puts forward the converse proposition, namely, that man has settled in those areas where the rate of erosion is greatest. "A high rate of erosion is usually coincident with a heavy rainfall, and these two facts together tend to make the wide, fertile plains which, naturally, are the chief habitat of man on this Earth." But these wide, fertile plains are the results of deposition, not of erosion. If man settles in areas where the rate of erosion is greatest, why are not the great centres of population in the mountain regions instead of in the plains? The rate of erosion varies in the different parts of a river. It is probably greatest in its early middle course, where it debouches from the mountains. Hence its volume is much greater than in the mountains, and its gradient is still comparatively steep. In the plains, however, erosion is almost balanced by deposition. During the formation of the great alluvial plains deposition must actually exceed erosion in the lower reaches of the river. The whole point is that man, by the cultivation of the land, by stripping the protective covering of herbage and trees, tends to disturb this nice balance between erosion and deposition, and to tilt the balance in favour of erosion.

ABNORMAL STREAM TRANSPORT IN PERTHSHIRE AND ARGYLLSHIRE.—Mr. J. Gurney Barclay, in the above-cited letter, also states that British geologists are apt to base their estimates of erosion on what they see in the British Islands, disregarding the far grander manifestations of the erosive power of rivers and other agents in more mountainous countries. This is to some extent true, and illustrates the corrective habit of travel, in geological as well as in other fields of human activity. In the Scottish mountain districts, however, we have occasional manifestations of erosive power that recall, if they do not rival, those cited by Mr. Barclay in Japan. For example, the storm of August 5th, 1912, in the Cowal district of Argyllshire (W. R. Smellie, *Transactions of the Geological Society of Glasgow*, Vol. XV, Part I, 1914), wrought an amount of damage that required £10,000 of the Cowal ratepayers' money to make it good. On the above date a great thunderstorm broke over the district after several

days of heavy rain. Whilst the collecting areas of the streams in this district are quite small in relation to rivers in general, their peculiar shapes made inevitable an enormous transport of material. The following is Mr. Smellie's statement of the peculiar conditions: " . . . (*a*) A comparatively large drainage area with the numerous headwaters situated at approximately equal distances from the mouth of the main stream; (*b*) side-streams with steep gradients, about 1 in 2·6 . . . main streams with gradients which could be as low as 1 in 6; (*c*) streams debouching suddenly on to an almost flat alluvial plain. Given these conditions in any part of the affected area, and a disastrous transport of huge boulders (ranging up to six feet in diameter) was inevitable. The large gathering-ground accounted for the large volume of water, the arrangement of the tributary streams ensured the simultaneous arrival of their contributions, and the gradients implied a very high velocity." Tremendous masses of great boulders and trees were piled on to the alluvial flats, and spread over the adjacent road. At Barnacabben " the stream forked as soon as it met the alluvial plain, and just in the fork, and facing the gully, a small house was situated. As in the former case, the boulders, unable to divide with the stream channels, drove straight on and through the house, wrecking it utterly, and leaving only two battered end-on gables rising from a heap of boulders." Mr. Smellie concludes that streams, during a few hours' exceptional activity, can accomplish more work than they could in several decades at their ordinary rate.

Almost identical phenomena were witnessed in Upper Strathearn, Perthshire, during and after a great three hours' storm on Wednesday, August 24th, 1910. An excerpt from Mr. P. Macnair's paper, describing the effects of this storm will show the character and rate of the erosion (*Transactions of the Glasgow Geological Society*, Vol. XIV, Part II, 1911). " According to eye-witnesses, the ground seemed to tremble as if affected by an earthquake, and every now and then huge boulders came into collision with each other, making a noise like the sound of distant artillery. Near the bridges over the road and railway, the stream having been constricted, piles of boulders and sand were accumulated. At these obstructions the water rose high in the air, tossing about huge tree-trunks and boulders as if they were pieces of straw." Some of the boulders carried down were estimated to weigh three tons, whilst many hundreds weighed from one to two tons.

METEOROLOGY.

By WILLIAM MARRIOTT, F.R.MET.SOC.

IS THE EARTH DRYING UP?—Professor J. W. Gregory, F.R.S., discussed this question at a recent meeting of the Royal Geographical Society. Owing to the varied nature of the evidence to be considered, the extensive and scattered literature whence much of that evidence has to be gleaned, and the contradictory opinions expressed by high authorities, the problem whether the Earth is drying up is hedged about with difficulties. But one fact seems to result clearly from the evidence: there have been many widespread climatic changes in late geologic times, while in historic times there has been no world-wide change of climate. If particular countries are considered, such as Egypt and Palestine, the balance of expert opinion is strongly in favour of the view that there has been no climatic change in either since the earliest existing records. The belief in a lesser rainfall in Palestine has been fostered by the oft-repeated comparison of the Hebrews between the stony wilderness of Sinai and the matured fertility of Canaan. But it may be concluded, from the most precise tests now available, from the range of the date palm and the vine, and from the facts recorded by Old Testament writers, that the climate of Palestine is the same to-day as in the time of Moses.

Returning to the wider question, geological evidence shows how the passage from the climate of the Glacial period to that of our own day has been a gradual rise in temperature since the disappearance of the ice, accompanied either by an increase or decrease in humidity. In other countries the glacial conditions were succeeded by a warm, dry period, followed again by wetter conditions. This increased humidity characterises the present climates of Scandinavia, Germany, Hungary, Roumania, the eastern and southern parts of North America, parts of Africa from Nigeria to Cape Colony, and there is some evidence of the same change, following a dry post-Glacial period, in England.

As an increased rainfall has been demonstrated for so many parts of the world, it is only natural to expect a compensating decrease in other districts; and there is, accordingly, a predisposition to accept the claim that Central Asia is suffering from increasing desiccation. Yet it is well to remember that the extent of such change may be easily exaggerated by attributing to recent climatic changes the effects of prehistoric variations. For archaeological and historical evidence shows that Central Asia, and even the coasts of Persia and Baluchistan, had a very arid climate in the earliest times of which we have human records; that the Caspian Sea was at least as small and as low in the fifth century as it is now; and that the African and Asiatic deserts are in places again passing under cultivation, though it must be admitted that, while there is a strong balance of opinion in favour of the view that the aridity in Asia is being still increased, there are weighty authorities on the other side.

Professor Gregory says that the explanation of the conflicting views may be that in Central Asia the desert is widening in some places and contracting elsewhere. That the total rainfall in Central Asia has diminished is, however, probable, as an accompaniment to its increase in parts of Europe. Variations in the distributions of rainfall must result from any considerable alteration in the level of the land; the uplift of a continent must cause the rainfall to become heavier on the margins and lighter in the interior. The increase of rain on the coast lands would, however, hasten their lowering by denudation, and, again, the rain would sweep over the interior; hence that marvellous geographical equilibrium which has rendered possible the unbroken course of evolution would in time, unless checked by renewed uplifts of the coast lands, restore the more even distribution of rain, and revive the desolate regions in the heart of a continent.

REMARKABLE UPPER-AIR RECORDS AT BATAVIA.—Dr. W. van Bemmelen, in a recent letter to *Nature*, stated that two sounding balloons, which were liberated at Batavia during the past rainy season, met with exceedingly low temperatures when entering the stratosphere at the usual height of about 17 kilometres (10·6 miles). On December 4th, 1913, −90°·9 C. (−131°·6 F.) was registered, and on November 5th, −91°·9 C. (−133°·4 F.). Though in the latter case the clockwork had stopped, Dr. van Bemmelen says the register may be accepted without reservation. This air temperature of −91°·9 C. is the lowest on record.

On December 4th the balloon reached a height of 26,040 metres (16·2 miles). What is most remarkable in the temperature record is that from 17 kilometres upward an increase from −91°·9 C. to −57°·1 C. is shown, the latter agreeing with the value that is usually found in Europe. In former balloon ascents made in Batavia, temperature records have been obtained only twice for heights above 20 kilometres. In one of those cases (August 6th, 1913) an increase similar to that of December 4th was recorded, viz., −82°·6 C. at 17 kilometres, and −63°·7 at 22 kilometres; in the other case, however (October 2nd, 1912), the temperature showed a much smaller increase (−80° C. to −75° C.), the balloon reaching 23 kilometres.

XUM

CLIMATE AS TESTED BY FOSSIL PLANTS.—At the meeting of the Royal Meteorological Society on March 18th Professor A. C. Seward, F.R.S., gave a lecture on "Climate as Tested by Fossil Plants." Problems connected with the climates of past ages have long exercised the minds of scientific writers, both from an astronomical standpoint and from the point of view of the gradual development and wanderings of plants and animals since the earliest periods that have left recognisable records. An estimate of the value of plants as "thermometers of the ages" necessitates an enquiry into the power of acclimatisation of recent plants and their ability to respond to external stimuli: a comparison of land and water plants illustrates the plasticity of vegetative organs, and the intimate relation between form, structure, and environment; similarly, plants growing in dry places, or under other conditions unfavourable for the absorption of water, are characterised by certain structural features reflecting the circumstances in which they live. A comparison of individuals of the same species grown at high altitudes, at lower levels, or before continuous light, afford striking evidence of the power of adaptation. The difficulty of using fossil plants as tests of climate becomes increasingly great in proportion to the degree of difference between the extinct types and their nearest living relations. It is from the examination of petrified plants, the delicate tissues of which are almost perfectly preserved, that data may be obtained throwing light on climatic conditions. This method of enquiry is best illustrated by a consideration of some of the anatomical features of the leaves, stems, and roots of trees which grew in the forests of the coal period; the form and arrangement of cells in the leaves indicate fairly bright sunlight; large spaces in the cortex of roots point to growth in swamps. The geographical distribution of plants during the latter part of the Palaeozoic era affords evidence of the existence of two botanical provinces, a northern province characterised be a luxuriant flora living under conditions more genial than those to which the poorer flora of the southern hemisphere was exposed. The presence or absence of rings of growth in the petrified stems of plants may afford evidence of the occurrence or absence of seasonal changes. A general survey of the Jurassic flora of the world leads to the conclusion that the climate was comparatively uniform, and in Arctic and Antarctic regions much more genial than at the present day. The fossil floras of more recent geological periods furnish clear evidence of subtropical conditions in Europe; in later times the occurrence of northern types in Britain heralds the approach of the Glacial period, and in post-Glacial beds are found fragmentary remains of immigrants from neighbouring floras which have largely contributed to our present flora.

MICROSCOPY.

By F.R.M.S.

NICTERIBIA.—In many cabinets of microscopic objects there will be found mounted specimens of what are variously labelled "Parasite of Indian Bat," or "Parasite of Flying Fox," the structure of which is so peculiar that those who have not yet examined it are strongly recommended to do so. The bat itself is one of the Megachiroptera, or fruit-eating variety, and is found only in warm climates. Like most other creatures, it is afflicted with ecto-parasites, the chief of which is the *Nicteribia* under consideration. The body of this parasite measures from ·175 inch to ·235 inch in length in the male, and is about ·25 inch in the female, but the legs are about ·3 inch in both. The head, furnished with maxillary and labial palpi, is, when at rest, folded back, and rests in a depression on the dorsal surface of the thorax. The eyes are simple, and five in number on each side, ranged round an elevation similar to that of the vertex in the flies. The rostrum, apparently, consists of two parts, serrated at the ends, and forming a tube when placed together. The rapid and peculiar motion of a bat when flying would seem to render special provision necessary to enable its parasite to hold on; hence we find a curious comb-like structure on each side of the ventral portion of the thorax, between the first and second pair of legs, and a similar comb along the edge of the first abdominal segment, the former consisting of about fifteen spines, and the latter of about forty, these being admirably calculated to catch in and hold on to the remarkable imbricated hairs of the bat. The body and legs of *Nicteribia* are covered with smooth, tapering hairs, of various lengths, which form a fringe round the extremity of the abdomen in the female. The spiracles are six in number on each side, but do not present any unusual features. The legs are long in proportion to the size of the insect, the tarsus consisting of five joints, of which the first is long, slender, and flexible, and the four which follow—the last one bearing the claws—are short. The claws themselves are sharp and much recurved, and two small pulvilli extend from the base of the claws. The particular specimens described are believed to be *N. hopeii*, but other species are known, and occasionally mounted as microscopic objects.

The Nicteribiidae, though wingless, are placed by entomologists in the order Diptera. R. T. L.

THE RADULA OF *HELIX RUPESTRIS* (DRAP.).—Six years ago I stated (*Proc. Malac. Soc.*, VIII, 126) that the radula of *H. rupestris* was like that of *lapicida*, and quite unlike that of *rotundata*. Some doubt having been thrown upon this statement, I have now reëxamined the species, using fresh material. I find that the resemblances and want of resemblance are still as they were: *lapicida* and *rupestris* have broadly conical central and admedian mesocones, the ectocones being more or less completely hidden. *Rotundata*, on the other hand, has very prominent ectocones throughout, so that the appearance of the middle of the radula is equally distinct and characteristic. The external basal plates in the two former species are oblong, and three or four times as long as they are broad. In *rotundata* the oblong is irregular, and the relation of length to breadth is more like two to one. The cones of the external unci form regular pectinations in *rupestris*, and occur in equal groups of three or four in *lapicida*; while in *rotundata* they are uneven, and of the Arionid type. The regularly pectinate form is found in young *lapicida*, as in *rupestris*. In *rotundata* embryos the form is serrate, not pectinate. The embryo *rupestris* (as found inside the parent shell) has three admedians: these with the central show ectoconic differentiation, as all young Helicids do, but the central mesocone is already stout and ovate. At no stage do we get the lancet-shaped cones so characteristic of *rotundata*. The *rupestris* embryo has five pectinate externals: its basal plates are square and oblong, like those of the adult. An adult specimen has 172 rows of 37 (11, 7, 1, 7, 11) unci. Another has 181 rows. Thus the total number of unci will be six or seven thousand. There is no great difficulty in extracting the radula of *rupestris*; indeed, it comes to daylight more easily than that of *pomatia*. In order to see the details of the cones, it is at least advisable to use an objective of N.A. 0·9, and apochromatism is here more than an advantage—almost a necessity. With bad definition in the objective or faulty adjustment of the condenser it is easy to be misled by false images of the lacinial margins. By injudicious use of the iris diaphragm it is possible even to see such things as are depicted in the usual drawing of *Punctum pygmaeum* (radula). But I am forgetting—surely no reader of the Microscopy column of "KNOWLEDGE" requires these elementary hints. E. W. B.

PHOTOMICROSCOPY.—The Photomicrographic Society, which is just at the close of its third year of existence, continues to do much good work. The general trend is that each worker should restrict his general work to some fairly

well-defined line. This development towards specialisation has the support and encouragement of all the leading workers. The President for the time being, Dr. Rodman, rightly supports this policy, both by precept and example. His presidential address took the form of a lecture on the study of pollen grains, which extended to some thirty or more orders of British plants. These objects lend themselves particularly well to reflected (top) light on a dark ground. It would appear that, as a rule, plants belonging to the same natural orders display a strong family resemblance in the form of their pollen grains, though here and there one meets with very marked departures from the type of the order. The size of the pollen grains bears no immediate relationship to the size of the plant. Naturally, the pollen of anemophilous plants is smaller in size, and so better adapted for wind-carriage, while the larger size of the entomophilous plants is not so likely to be missed by visiting insects. Some simple and quick method of mounting pollen without pressure would be an acceptable addition to our craft. Some little time ago Mr. Noel Heaton discoursed on the microscopic examination and photography of some gem stones; whence it was gleaned that one of the ways of distinguishing between natural and synthetic rubies was by regarding the form and arrangement of certain tiny bubbles, which in the one case were more or less spherical, and in the other elongated to ellipsoid form. Indeed, in some cases one saw a moniliform arrangement, reminding one of the droplets on the thread of a spider's web. But in the two cases the causes were hardly comparable at all.

Owing to the kindness of the firm of Messrs Leitz, whose English branch is in the capable hands of Mr. J. W. Ogilvy, the Photomicrographic Society was able to hold one of its evening meetings at the Leitz establishment in Bloomsbury Square. On this interesting occasion somewhat of a record in photomicro-projection was made. A large and characteristic series of rock-sections had been cut, mounted, and photographed by Mr. C. H. Caffyn. These photomicrographs were taken with polarised light on colour-screen plates. When such microcolour-pictures are projected on the screen, everyone asks, "Are those the exact colours you saw through the microscope?" There is only one satisfactory answer to such a question, *i.e.*, by showing the original and the photographic reproduction side by side, so that all their corresponding parts may be leisurely compared. On this occasion a specially designed projection microscope was used, and matters so contrived that on a large screen there was projected the photomicrograph in colour, and alongside it a projection image, through the polarising microscope. To make matters more complete these two pictures agreed precisely in size and subject, *i.e.*, two versions of the same thing. The closeness of the resemblance in the big majority of cases was quite startling, and says a very great deal for the joint authors of the display, viz., Messrs. C. H. Caffyn and J. W. Ogilvy.

INTELLIGENCE IN PARASITIC ROTIFERS.—(1) Acts of intelligence in Rotifera seem to be most clearly shown in parasitic species, and on observing their behaviour under the microscope one cannot help coming to the conclusion that these acts are controlled by the tiny speck of clear, transparent brain, which one can look through and into at the same time.

The most common of parasitic Rotifers are the two small species inhabiting the green moving spheres of *Volvox globator*: *Proales parasita* Ehrenbg. and *Hertwigia volvocicola* Plate. Both can live and swim about freely in the open water, but they usually find it more convenient to ride luxuriously inside the roomy saloon of a Volvox, which at the same time provides them with a larder, for they feed on the young buds and green gonads of the plant (or animal), and then lay their eggs and raise a family, all in the same protected and private apartment, and whilst sailing about the world. It is curious to watch how one of these Rotifers first manages to gain an entrance into the green sphere. The little Proales fixes itself to the surface, and by means of its pincer-shaped jaws bites a small hole through the thin skin of the Volvox, very much too small to allow of the passage of its body, and particularly of the stomach, which usually is the stoutest part of it; then the head is pushed through, with much wriggling, pushing, and exertion: the work is continued till half the body is through. At this stage the animal looks like a dumb-bell, half inside and half outside the wall of the Volvox, with the thick stomach and its contents outside, looking as if there were very little chance to succeed in its task. Just then a very clever trick is performed by the little Rotifer, one of those acts which are done, not mechanically, but appear to be thought out with due appreciation of its effects and results. It stops wriggling, but pushes the contents of its stomach back, then passes the empty forepart of the stomach through the constricted part of its body, followed by the contents, particle by particle, like sand-grains pass through the narrow part of an hour-glass, and one can watch the stomach gradually growing and filling on the other side of the wall. After the contents of the stomach and intestine have thus passed over, the remainder of the body glides through readily, and the little Proales is inside the Volvox, ready to explore its new habitation. One would think that it would have cost little extra labour to bite a somewhat larger door in the wall of the Volvox, in order to obtain an easy entrance; but no, the smallest, almost imperceptible, hole is made, apparently to ensure privacy and prevent enemies and competitors from gaining an entrance into its domain. I have not yet observed a fight in defence of this small open door, but one can readily imagine how helpless an intending intruder would be when held firmly half inside and half outside of the wall, and what an easy task the person in possession would have to defend his house and home, though it be a freebooter's. It is true that several specimens are often found in the same Volvox sphere, but these are sisters, born there from eggs laid by the parent.

Ehrenberg's popular name for *Proales* (*Notommata*) *parasita* was "the pirate" (*der Raubschiffer*), because it was sailing in a captured craft. It may be mentioned also that this species is not Gosse's *Proales parasita*. The latter is a small barrel-shaped Rotifer without a foot, resembling members of the genus *Sacculus* (*Ascomorpha*), which was later described by Plate under the name of *Hertwigia volvocicola*. Both species are often met with in different gatherings of *Volvox globator*.

C. F. ROUSSELET.

(*To be continued.*)

THE QUEKETT MICROSCOPICAL CLUB.—At the meeting of the Quekett Microscopical Club, held on March 24th, 1914, Mr. N. E. Brown, A.L.S., read a paper on "Some Notes on the Structure of Diatoms." The chief part of this paper was an account of the observation of very minute pores, having a diameter of the order of 0·1μ, in a *Pinnularia*, *Pleurosigma balticum*, *P. angulatum*, *Surirella gemma*, *Nitzschia scalaris*, and several other forms. A one-twelfth oil-immersion of N.A. 1·3, and eyepieces to bring the magnification up to at least one thousand diameters, and often not less than two thousand diameters, combined with very careful manipulation, a most exact arrangement of the light, and a fair stock of patience, are required to make the structure clear. The author was led to search for these pores by observing, on several occasions, behaviour of diatoms which could be most reasonably explained by assuming the presence of exceedingly fine pseudopodia, having a length of about 1/3000 inch. Mr. E. M. Nelson, F.R.M.S., described the new Zeiss one-seventh oil-immersion short-tube objective. This has N.A. 0·9. The corrections are very perfect. Although no fluorite is used in its construction, it shows a considerable advance over semi-apochromatism, and exhibits only a slight trace of outstanding blue. It will just show the striae on *Grammatophora oceanica* (88,000 to the inch). The capabilities of the new objective were exhibited by Messrs. Zeiss on four stands. Mr. E. M. Nelson, F.R.M.S., also discussed "A

New Way of Using an Object-glass for Diatom or other Resolution." It is as follows :—

1. Place the diatom so that its striae to be resolved are vertical in the field.

2. Set up a critical image with the edge of the flame in focus and central to the field, and open the iris to its fullest extent.

3. By means of the substage centring screws move the condenser so that the image of the flame lies just outside the field of a high-power eyepiece. If the striae are within the limits of the objective they will be at once resolved without any trouble with stops, slots, or other apparatus.

The President, on behalf of the Club, offered to Mr. T. H. Powell, F.R.M.S., one of its oldest members, hearty congratulations on the attainment of his eightieth birthday. Mr. Powell joined the club in 1865. In spite of his great age, he is still able to take an active part in microscopy ; and at the conversazione of the club, in February, exhibited an object, under a high-power objective, constructed by himself. Mr. Powell acknowledged in suitable terms the very hearty reception of the President's remarks by the members.

On April 4th the first Saturday afternoon excursion of the season took place, the Botanic Gardens, Regent's Park, being visited. The attendance was good, although the weather was somewhat unpropitious. Specimens in the various fields of research were obtained from the large lake. *Eudorina elegans* was extremely abundant, examples showing the division of the contained individual cells into juvenile colonies, preparatory to multiplication, were numerous. The minute flagellate organism, *Dinobryon sertularia*, was plentiful in the same gatherings. The remarkable resemblance in general outline to the marine *Sertularia* gives it an interest, while, from its small size, movement, and transparent delicacy, it forms an object by no means easy to observe satisfactorily.

At the " Gossip Meeting," held on April 14th, notwithstanding its proximity to the Easter holidays, there was a good display of microscopes and objects by members. *Callidina papillosa*, *Conochilus volvox*, *Mniobia tetraodon*, *Habrotrocha constricta*, *Callidina vorax*, and *Adineta sp.*, among the Rotifera, were shown, as was also *Bursaria vorticella*. A Caddis tube formed of sand, opened out and exhibited under polarised light, was attractive, while a section of leaf of Meadowsweet, showing a gall formed by *Cecidomyia ulmariae* was under one instrument. A large number of insects of very various kinds, ants, flies, beetles, wasps, etc., preserved in eucalyptus oil, had been forwarded by a correspondent in South Burma for distribution among the members, who gladly availed themselves of the opportunity of acquiring such examples of exotic life. A quantity of " pond life," both animal and plant, in preservative fluid, from the same source, was also provided, and taken advantage of.

PHOTOGRAPHY.

By EDGAR SENIOR.

TRANSPARENCIES ON COLLODION EMULSION.—It has long been recognised that for certain purposes, such as in the production of cloud negatives, collodion is superior to gelatine, and as collodion emulsion can now be rendered isochromatic, and at the same time an increase of sensitiveness imparted which approaches to that of a modern gelatine plate, the difficulties of prolonged exposure no longer present themselves. Then, again, a desirable quality in a cloud negative is, that it should be possible to print from either side of it, and for this reason a film negative is preferable to one on glass; and as collodion lends itself particularly to stripping, either by means of a solution of gelatine poured on and allowed to become dry, or by the use of the lotus films already described in a former article, this is a special recommendation in favour of the use of collodion. But it is in transparencies, either for the lantern or other purposes, that collodion emulsion holds its own, in spite of the many brands of gelatine plates specially prepared for this class of work. The preparation of washed emulsions has now been reduced to such simplicity as to be readily accomplished by anyone taking ordinary care. For transparencies there is no necessity for great rapidity in the emulsion. The chief secret appears to lie in using a suitable pyroxyline in making the collodion. There is no necessity, however to make the emulsion " except for those who are interested in doing so experimentally," as excellent emulsion is to be purchased ready for use, such as that supplied by Messrs. A. W. Penrose & Company, of 109, Farringdon Road, London, which the writer has employed with the greatest success on many occasions. There is a great advantage in the use of collodion emulsion, as so much can be done with the image after it is fixed. As an example, a very thin image can be readily intensified until a satisfactory result is obtained, and this operation can be carried out in daylight, without any risk of staining the film, which will still remain clear glass in the high lights. Then, again, any trace of fog, due to over-exposure or development, can be very readily removed. However, if much after-treatment is required it will be found necessary to resort to some means for preventing the film leaving the glass during the manipulations. For this purpose a substratum is frequently recommended, although it is not advisable to employ one, as it is the frequent cause of spots, stains, etc., and a good edging of india-rubber dissolved in benzol is all that is required, and answers perfectly. The india-rubber solution employed by the writer is made as follows :—

India-rubber (pure)	6 grains
Benzole (pure)	1 ounce

This is applied for about one-eighth of an inch all round the plate " which has been previously made chemically clean," and when dry the plate is ready for coating with the emulsion, which must be done to the very edges, as well as the extreme corners, since if any place is missed the water used in washing will get under the film and cause trouble, while if the edging and coating be properly carried out almost any force of water may be applied without risk of damage. It is advisable, however, to always keep the plate in an horizontal position. The colour of the image will depend chiefly upon the exposure, although it is modified to an extent by the developer employed; but where warm tones are required a full exposure must be given, as a short exposure results in cold tones. For fixing, potassium cyanide has certain advantages over hypo, but whichever is used the following formulae should be employed :—

CYANIDE FIXING SOLUTION.

Potassium cyanide	20 grains
Water	1 ounce

SODIUM THIOSULPHATE (HYPO) FIXING SOLUTION.

Sodium thiosulphate	4 ounces
Water	20 ounces

After the image has been fixed and well washed, if there is any trace of fog it may be easily removed by means of a solution of iodine, followed by potassium cyanide, or the two may be used together. For use in this operation the following solution is made up :—

IODINE SOLUTION.

Potassium iodide	20 grains
Iodine	5 ,,
Water	1 ounce

A few drops of this are added to one ounce of water, when some of the cyanide fixing solution is added, drop by drop, until the sherry colour, due to the iodine, is completely discharged. The solution is then poured over the film and returned to the measure, the operation being repeated until the fog has disappeared, when the plate must be well and quickly washed. The operation of clearing can be done in daylight, and is a method well known to wet collodion

workers. After this treatment the image may appear too thin, and require intensification. For this purpose the following redeveloper should be employed :—

Pyrogallol	2 grains
Citric acid	3 ,,
Water	1 ounce

About half an ounce of this solution is taken, and a few drops of silver nitrate added, of a strength of about ten grains to the ounce of distilled water. This is poured on and off the film until the required intensity is obtained, when the plate is well washed. Should the image obtained be too warm in colour it may be modified by placing it in a solution of platinum bichloride of the following strength :—

Platinum bichloride	1 grain
Water	10 ounces

In this it will gradually change from red to purple, and, finally, black. The action, however, must be stopped short of the colour required when finished, as the image dries blacker. It must not be thought that, starting with a black image, the toning solution will give a warm tone, as warm tones, by development, are only obtainable by giving sufficient exposure, when, if too warm, the platinum solution will modify it. If by any chance the toning is carried too far, the image, after well washing, should have the cyanide fixing solution poured over it, when it will change to very nearly the same colour as at first, and may then be retoned to the desired depth. A properly prepared emulsion should give absolutely clear glass in the lights of the picture ; but with some samples of pyroxyline a slight milky or opalescent appearance is imparted to the film. This, however, will disappear on varnishing, but except in such cases it is better not to varnish, as it is very difficult to avoid specks of dust which show when the image is projected upon the screen. We have before us as we write a number of lantern slides made on collodion emulsion and developed with glycin, in which a solution made up according to the following formula was employed :—

Glycin	6 grains
Potassium carbonate	25 ,,
Potassium bromide	1 grain
Water	1 ounce

This developer gives a pleasant warm black colour itself, and beautiful gradation in the image, and the colour may be further modified by treatment, to different extents with Mr. W. B. Ferguson's copper ferrocyanide toning solution. The alkali used in the developer also affects the tone of the picture, carbonate of ammonia tending towards a red, while carbonate of soda imparts a greenish hue. But the chief factor in determining the colour is the exposure given to the plate.

PHYSICS.

THE APPLICATION OF POLARISED LIGHT TO ENGINEERING PROBLEMS OF STRESS AND STRAIN.—The action of glass in a condition of strain upon polarised light has long been known, although the phenomenon was regarded mainly as bearing on the conditions of stress existing within more regular crystalline structures. Professor E. G. Coker has for some time been investigating the subject from an engineering standpoint, and has from time to time brought the results of his researches before the scientific world, both at the Royal Society and the Royal Institution. The writer has recently had the advantage of hearing and seeing some of Professor Coker's latest results. Light from a powerful lantern was polarised by reflection, and the screen was made dark by a Nicol prism " crossed," *i.e.*, with its plane of polarisation at right angles. A xylonite model of a girder was then placed between the polariser and the analyser, and subjected to stress. Immediately the field became coloured, a dark line down the middle of the bar showing the region of neutrality. By the colour of the light at any particular point the stress at that point can be determined as accurately as by mathematical calculation. The colour depends on the stress, and is the same whether that stress be a tension or a pressure. The variations of stress in plates, and particularly the great increase of stress in the neighbourhood of sharp corners, *e.g.*, the corners of square holes in the model of the deck of a ship, were strikingly shown on the screen. Models of spiral springs, trains of wheels, and other contrivances served to illustrate the manner in which a phenomenon of what might have been thought to be of purely physical interest has been made to furnish results of importance to engineers.

W. D. EGGAR.

LECTURE ILLUSTRATION OF A MOVING CONDUCTOR IN A MAGNETIC FIELD.—When a carbon filament lamp is placed in the field of an electro-magnet, the one (preferably the lamp) being supplied with alternating current, and the other with direct current, the filament is set into violent vibration. This effect affords an illustration of a well-known phenomenon, and will probably interest readers of " KNOWLEDGE."

The carbon filament which I found to show the effect best was one with a fairly free helix, supported in the centre. The vibration was more violent when the axis of the helix was at right angles to the magnetic field than when it was parallel to it. If the magnetic field is sufficiently strong, the coils strike together, and in some cases present the appearance of having a curious spinning motion. If an alternating magnet and an alternating current filament of the same period be used, the effect is much smaller.

With a direct-current magnet and direct-current lamp a single motion of the filament is produced, but for this to be appreciable a rather strong field is required.

In order to utilise this effect for a lecture experiment, it is only necessary to project the image of the filament on a screen by means of a lens, the axis of the helix being parallel to the screen, and to bring the electro-magnet up behind the filament, and perpendicular to the helix, when the image of the filament on the screen broadens out ; a stroboscopic disc running slightly out of tune with the filament would render the motion on the screen slow, and easily followed. Since the magnetic field required is quite small, this effect with the alternating lamp or magnet provides a convenient illustration of the motion of a conductor conveying a current in a magnetic field.

J. H. T. ROBERTS.

ZOÖLOGY.

By PROFESSOR J. ARTHUR THOMSON, M.A., LL.D.

EYES THAT SHINE AT NIGHT.—Everyone knows the gleam of a cat's eyes when a light catches them in the darkness. This appears to be due to reflection from a layer behind the retina called the choroid tapetum. This layer includes numerous flat cells packed with crystalloid bodies which act like a mirror. In some beetles and moths the eyes shine like rubies when they are obliquely illumined at night. Professor Bugnion has recently studied the eyes of one of the hawk-moths (*Sphinx euphorbiae*), and finds that the retina is very thick and infiltrated with a rose-coloured pigment, " erythropsin." Part of the retina forms a tapetum, and the reflection is due to a network of silvery air-tubes, or tracheae, helped to some extent by movement of the retinal pigment. It is probable that the reflection of the light rays from the tapetum is advantageous, since the visual cells are thus affected twice instead of once.

THE FLIGHT OF THE HOUSE-FLY.—Dr. Hindle finds that house-flies tend to travel either against or across the wind. This direction may be directly determined by the action of the wind, or indirectly, owing to the flies being attracted by odours borne by the wind. Fine weather and

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warmth favour dispersal, and flies travel further in the open country than in towns—probably because the houses offer food and shelter. In thickly housed localities the usual maximum flight is about a quarter of a mile, but in one case a single fly was recovered at a distance of seven hundred and seventy yards (partly over open fenland). When set free in the afternoon flies do not scatter so well as in the morning. Liberated flies often mount almost vertically to a height of forty-five feet or more.

MATERNAL CARE IN EARWIGS.—H. H. Brindley notes that the eggs of earwigs are usually found in a little pit in the soil about an inch below the surface, or else in convenient crevices in vegetation. The mother watches over them, but there seems to be no foundation in the assertion that she guards the young. Before hatching she covers the little pile of eggs with her body or else plays over them with her antennae. After the young are hatched, and freed from the egg-membrane, which is sometimes difficult, the mother displays no interest in them. The newly hatched earwigs are active, and begin to feed in a few hours, possibly less. It may be noted that several authors of good repute have offered some confirmation of De Geer's statement that the mother earwig shelters the young.

TENACITY OF LIFE.—Various fungoid organisms have been known to survive twenty-two years' desiccation; various Bacteria have remained alive without air, but with moisture, for ten to twenty years; sediments, containing various Protozoa, have shown revivification after five to six years. F. Noc relates that some tubes, with a little water and various Protozoa, were hermetically sealed in 1908, and were recently examined. There was no trace of the Infusorians which were there to start with, but there were encysted Amoebae, some of which revived after ten days or so. Some Protozoa, dried on Tonkin commercial paper, were revived after five years. One of these was a small Flagellate (*Oikomonas termo*).

PECULIAR AIR-SAC IN A LEMUR.—In a species of *Microcebus* from Madagascar R. Anthony and I. Bortnowsky describe an extraordinary peculiarity—a large sub-cutaneous air-sac lined with stratified epithelium, extending all over the animal's back and out to the bases of the limbs. It seems to be in communication with the air-passages, probably with the windpipe behind the larynx; but this point remains for the time being undecided. There can be little doubt that the air-sac is in some way connected with the Lemur's arboreal life, and the investigators suggest that it has to do with balancing or equilibration.

ANTARCTIC NEMATODES.—In reporting on the free-living marine Nematodes collected at Cape Royds on the Shackleton Expedition Mr. N. A. Cobb calls attention to their abundance. Hundreds of them, males, females, and young, were taken from a mere thimbleful of the dredgings. Twenty-five new species are described, mostly vegetarian. They seem to be rather smaller than species in warmer seas, but they do not seem to be less prolific. "It is hardly conceivable that the body temperature of the marine polar species is higher than that of the water in which they live, namely, near the freezing-point of fresh water; and yet, in spite of the freezing temperature and the long polar night, Nematode protoplasm seems to glide on through its mitosis dance to much the same purpose as if bathed in equatorial light and esconced in the warm pools of tropical reefs."

YOUNG SAND-EELS IN THE NORTH SEA.—Dr. Alexander Bowman has shown that, with the exception of a relatively small number of specimens found in the neighbourhood of the Firth of Forth, no larval sand-eels occur in the plankton in the northern portion of the North Sea in the first two months of the year. They suddenly appear in countless numbers in the month of March. On one occasion as many as nineteen thousand eight hundred and sixty individuals (of *Ammodytes tobianus*) were captured near the bottom (where they are hatched) in a single horizontal haul of half an hour's duration. The spawning grounds are in great part determined by the depth and the character of the bottom; the eggs are not laid in very shallow or very deep water, or on a very muddy bottom. The frequency is low inshore and in the deeper parts of the central North Sea. The area of greatest frequency is in the vicinity of the Orkney Islands and the Pentland Firth, but the larvae occur with considerable uniformity along the east coast of Scotland from the Moray Firth to the Firth of Forth.

CONSERVATION IN EVOLUTION.—We have often had occasion to wonder at the apparent wastefulness of Nature, not so much in the winnowing, which casts so many individual lives as nothing to the void, as in the obliteration of fine types which were masterpieces in their day, and leave no direct descendants behind them as the legatees of their splendid qualities. But against this we have to place the great fact of conservation, that there is in a striking way a holding fast to that which is good. Thus we find that particularly effective modes of vital behaviour, some of which made a temporary fortune in their day, yet did not in the end save their possessors from utter ruin, have been caught up by collateral relatives and handed on as a legacy from very ancient days to the higher animals. Let us take a single illustration. Where would a higher animal be, what possibility of such a life would there be, were there not a persistence of that most primitive manifestation of life which we call amoeboid movement—the ebb and flow of a protoplasmic tide within the cell—so familiar to students of biology in Amoebae and white blood-corpuscles? How long would a higher animal survive without its bodyguard of phagocytes? Nor could it have become what it is had not its embryonic neurones flowed out into nerve-fibres, just like exploring Amoebae! It is very interesting that the only animal types without wandering phagocytes are the Nematode worms (some of which, at least, have stationary phagocytes) and the Lancelets. The Nematode worms do not seem to lead on to anything else; and the Lancelets, though near the base of the vertebrate branch, are specialised types in a cul-de-sac of their own. It is surely significant that man himself in the development of his nervous system, in the repair of an abrasion of the conjunctiva covering the front of his eye, in the everyday resistance of phagocytes to intruding Bacteria, and in every inflammation, serious or trivial, harks back in his cellular activities to the Amoebae gliding along on the mud of the pond.

THE BREEDING OF THE SALAMANDER.

The following interesting notes are extracted from a letter of Mr. Arthur C. Banfield. They refer to a Salamander which is now in the Reptile House at the Zoölogical Gardens.

"In April, 1909, I bought for my vivarium two Salamanders (*S. maculosa*): one of these died eight days later. The other was a well-marked, healthy specimen that thrived very well.

"Rather over two years later (in May, 1911) one night I saw that the Salamander was very uneasy, running to and fro restlessly, and then all at once it started bringing forth progeny. In three-quarters of an hour eleven were born, miniatures of the mother, except in the possession of gills. Three were devoured by a toad, and I rescued the rest and reared them in a separate case.

"I knew that Salamanders were viviparous, of course; but how was the mother fertilised? I imagined that these animals were far too high in the scale for parthenogenesis, but this is the only explanation I can think of. Perhaps your readers have heard of similar cases."

We are reminded, by this note, of the delayed gestation of the Badger.

PROTECTIVE CHANGES OF COLOUR IN ANIMALS.

(A New Theory.)

By L. BRITTON.

According to Dr. R. F. Fuchs, of Breslau, the changes of colour which are observed in the chameleon and other animals are not due to any attempt at imitating the colour of the surroundings in order to protect them from their enemies, but represent an effort to regulate the temperature of the body by making use of the different absorptive powers of the various colours for heat. His arguments are certainly very ingenious. He points out that mammals and birds possess these cells, but are unable to effect any change of colour by their means, the reason being, in his opinion, that by the aid of their sweat-glands they are able to keep the temperature of the blood within proper limits, by reason of the large amount of heat rendered latent in evaporation. It was asserted by Rubner that the primary necessity for animals is to prevent overheating of the blood by the continuous chemical changes of the body, and it is upon this theory that Professor Fuchs works. The changes of colour in such animals as the chameleon are effected by means of cells, called chromatophores, situated in the cutis, and filled with pigment of various colours. These cells are capable of enlargement or contraction when they undergo changes of colour. Following out the theory of Rubner, Professor Fuchs points out that these chromatophores exist as active cells in cold-blooded animals alone, and that in no case is a warm-blooded animal by their means, even if possessing chromatophores, able to effect any change of colour.

In mammals, as man, for instance, the cooling of the blood takes place by evaporation from the skin of the body, but this process cannot subsist among the fishes and aquatic animals. Accordingly, if the theory be true, it is here that we must look for instances of colour change; and it is here, in such animals as the goby or squid, that we actually find it. But the most striking argument brought forward is the fact, according to the Professor, hitherto quite unnoticed, that in the great phylum Arthropoda it is only the marine crustacea that are able to effect a change of colour, while the genera living on the land (myriapoda, insecta, spiders) are totally devoid of this power, contact with the air sufficiently enabling them to regulate the heat of the blood.

The chameleon itself, the best known of all the colour-changing animals, and the first one that springs to everybody's mind, certainly seems at first sight to be a contradiction of the Professor's theory, since, although a cold-blooded animal, it lives in free contact with air, and apparently has every opportunity to secure due evaporation; but on examining the matter more closely it is found that the scaly, or armour-plated, reptiles are not in this respect to be compared with mammals or birds, for their skin covering effectually prevents contact with air; and, even if it were not so, these animals in every case, either entirely or almost entirely, lack the cutaneous glands necessary to achieve the purpose.

Amphibia, again, show transitory colour-change; but this is also explained by the fact that the larvae are always aquatic, and even after having become full-grown haunt, for a greater or shorter length of time, moist places, where evaporation from the skin is more or less checked. Similarly, the increase of colour of certain animals at breeding time is explained by the necessity of greater animal heat at this period.

So far, then, the theory stands as a very fair attempt to account for the facts, but unfortunately objections are disposed of rather summarily. It is hard to see why, on such a theory, animals should in any way take on the colour of their surroundings; but, instead of dealing with the difficulty, the Professor dismisses it with a single sentence as due to reflection. The matter may seem to him a very simple one, but it certainly deserves better treatment for those who are not already convinced of the truth of his theory. Further, a theory must be made consonant with other facts, and it is plain that when an Arctic fox or a stoat takes on its summer dress it is not that heat is a factor in deciding the colour; for then it would be more probably white in summer, to reflect the rays of the sun, and keep cool. Admittedly, the colour of fur is not the same thing as the colour of pigment-cells or chromatophores, but the protective theory is consonant with both series of facts, and therefore, other things being equal, receives a prior right to our support. Nevertheless, facts of such weight as have been brought forward by Professor Fuchs decidedly require an answer.

CORRESPONDENCE.

HAMPSTEAD SCIENTIFIC SOCIETY.

To the Editors of " Knowledge."

Sirs,—Students and lovers of nature have only too much reason to fear that the rapid development now going on in the country between Hampstead, Willesden, Hendon, Finchley, Muswell Hill, and Hornsey may mean the speedy extermination or enforced retreat of the majority of the animals and plants which have hitherto contributed so largely to the charm and interest of the neighbourhood.

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An effort is now being made, on the initiative of the Hampstead Scientific Society, to compile, before it is too late, a complete record of all the natural species still to be found within three miles of the flagstaff on the summit of the Heath. In the book which the Society published last year on "Hampstead Heath, its Geology and Natural History," were collected all the available records of species observed down to 1912. The result must have been a revelation to many of the residents in the district. How many, even of the older inhabitants, had suspected that the list of local mammals includes badgers, hares, hedgehogs, squirrels, and six kinds of bats; that the wanderer on the Heath may come across lizards and snakes; that the ponds and the Brent contained eight kinds of fish, besides microscopic creatures uncountable; that a list of three hundred species of flowering plants has to confess to incompleteness, even when added to one hundred and ninety-three kinds of trees; that two hundred and seventy different birds have been recorded within the three-mile radius; that a Cambridge University lecturer on botany can fill twenty-six pages with a "brief sketch" of the vegetation of the Heath and woods; and that even the varieties of molluscs (slugs and snails and pond mussels) run into three figures.

May I urge upon your readers the importance of these and similar records, as, for instance, those of butterflies, moths, mosses, and fungi, being completed and kept up to date while there is yet time, not only for the sake of scientific knowledge, but also in the hope that the interest thus aroused may do something to foster the preservation of the species that still remain?

Any residents within the district who are willing to assist, either by reporting casual observations or by joining in definite local surveys or schemes of research, are invited to communicate with the Honorary Secretaries of the Society at 32, Willoughby Road, Hampstead. It need hardly be added that the coöperation of other Natural History Societies, in a combined effort to cover the ground, would be most gratefully welcomed.

W. M. FLINDERS PETRIE,
President.

PERFUMES OF LICHENS.

To the Editors of "KNOWLEDGE."

SIRS,—Allow me to call attention to the following inaccuracies in the Chemistry Notes on "Perfumes of Lichens" in "KNOWLEDGE" (Vol. XXXVII, March, 1914, page 113). "Other *lichens* containing odorous principles," and so on, should read "other *plants*," and so on. *Conocephalus conicus* is an hepatic, and *Hygrophorus agathosmus* (not *agathosus*) is a fungus. Many of the fungi contain odorous principles.

T. B. ROE.

9, YORK PLACE,
SCARBOROUGH.

FOLK-LORE MUSEUMS.

To the Editors of "KNOWLEDGE."

SIRS,—I notice your contributor, Mr. W. Ruskin Butterfield, refers to the fact that doubts have been expressed as to whether the proposal for a British Folk-lore Museum has not come too late in the day for effective fulfilment. He also opines that with regard to folk-lore material museums have hitherto neglected it or treated it with scant regard, and says: "The eyes of Curators have been fixed in the ends of the earth, and the objects illustrating the culture-history of our own people have, for the most part, been overlooked." Had Mr. Butterfield been writing some years ago, there might have been some justification for the statement; but as one who is fairly familiar with most of the museums in this country, and their publications, I can assure him that folk-lore is by no means neglected. In fact, many of these institutions, especially during the past decade, have made a strong feature of such exhibits. It is admitted that in a few places there still may exist examples of the old-fashioned type of so-called Curator, who wears long hair and a chronic semi-imbecilic expression, and seems to use his energies in offending possible donors; but they will all die in time. The pity is that our laws will not enable us to stuff one to be placed among the "bygones" section of a folk-lore museum.

Of course, it is quite possible that some may consider that the day has gone by when sufficient material could be collected for the purpose of a folk-lore museum. It is also possible—in fact, probable—that there are those who consider that all museums are useless; but surely such opinions and those who express them are unworthy of consideration.

If one or two museums to-day may not be devoting sufficient attention to folk-lore, there are plenty of private individuals who are sufficiently intelligent to do so, and their collections will doubtless eventually find their way into some public institution. There is as yet no shortage of suitable exhibits, though it is admitted they are daily becoming more difficult to secure.

T. SHEPPARD.

THE MUSEUMS,
HULL.

REVIEWS.

ARCHAEOLOGY.

Prehistoric Times.—By the late RIGHT HON. LORD AVEBURY, D.C.L. Seventh edition. 623 pages. 283 illustrations. 9-in. × 6-in.

(Williams & Norgate. Price 10/6 net.)

Lord Avebury will be remembered for many things, but honour is due to him very particularly for the interest which he aroused in prehistoric antiquities, and his recognition of the various stages of culture which they represent. His book, entitled "Prehistoric Times," brought before the public Lord Avebury's ideas on the subject, and the volume under consideration is the seventh edition, which was thoroughly revised by Lord Avebury shortly before his death. The work has been entirely reset, and a number of new illustrations has been introduced. To those who have not had the pleasure of studying any previous edition we may say that from the book they will gain a very clear insight into the habits, work, and artistic expression of our remote ancestors who flourished before the time of written history. W. M. W.

BIOGRAPHY.

Lord Lister: His Life and Work.—By G. T. WRENCH, M.D. 379 pages. 4 illustrations. 9-in. × 6-in.

(T. Fisher Unwin. Price 15/- net.)

"A scientist's public life lies in the work that is his," says Lord Lister in the life of his father in the "Dictionary of National Biography," and Dr. Wrench has kept this maxim well before him in the Biography he has written. The details of Lister's private life are few and scanty, but the description of his scientific observations and the terrible condition of the surgical wards of hospitals in the first half of the nineteenth century that called for them are clearly and graphically told. The story reads like a novel, and, while we are bound to confess that the whole work is ably written, particularly is this the case with the earlier chapters of the book.

It is false to say that Lister stumbled on a great discovery, as we are sometimes told. Dr. Wrench tells us how slowly, laboriously, and step by step the causes and prevention of septic decomposition in wounds were discovered,

and explains that the whole of the principles of the present antiseptic treatment of wounds is due to the genius of this truly great man. With all this we gladly acquiesce, but when Dr. Wrench, in one of his later chapters, takes up forty-five pages to endeavour to prove that with the death of Lister all possibility of progress in the antiseptic treatment of wounds suddenly ceased, we are bound to disagree; nor can we help feeling that Lord Lister himself, who possessed the humility which is always associated with true genius, would equally readily repudiate the claims of infallibility set up for him by his biographer, and would be one of the last to assent to the proposition that, "when progress follows upon the work of one of the world's great men, my anticipation is that it will be progress downhill." Nevertheless, the book is really a good one, and its literary style is excellent. It is the best biography of Lord Lister that has yet appeared.

S. H.

CHEMISTRY.

Studies in Water Supply. — By A. C. HOUSTON, D.Sc., M.B., C.M. 203 pages. 43 illustrations. 9-in. × 6½-in.

(Macmillan & Co. Price 5/- net.)

The readers of "KNOWLEDGE" will be familiar with the work of Dr. Houston, for an outline of the main features of his Reports to the Metropolitan Water Board has been published each year in these columns. The present volume is intended not so much as a treatise upon water supply as to embody the results of the author's personal experience and investigations, which have hitherto been scattered in various publications. At the same time a large amount of more general information is necessarily included.

The subjects discussed include the use of rivers as sources of supply, processes of purification and sterilisation, the effect of storage upon bacteria, and the question of water-borne disease and endemic typhoid; while the later chapters deal with practical bacteriological methods and statistical information. The book is well illustrated with diagrams, figures of apparatus, and photographs of algal growths, and has a particularly full index.

It is not too much to say that this monograph is absolutely indispensable to all who have to examine water, or whose business it is to ensure a pure water supply. A copy of it should be upon the shelf of every chemist and every municipal engineer.

C. A. M.

ENTOMOLOGY.

A Textbook of Medical Entomology.—By W. S. PATTON and F. W. CRAGG. 745 pages. 89 plates. 10-in. × 7½-in.

(Christian Literature Society for India. Price 21/- net.)

The authors set out to "compile a guide to the study of the relations between Arthropods and disease, rather than a textbook of entomology." We think they have succeeded, but we wish the title had conveyed this clearly, and not given the impression that it was a textbook. Clearly, it is more a laboratory guide than anything else, and the medical officer who sets out to learn his entomology from this volume will become even more the one-sided "medical" entomologist than the average combination of medicine and entomology is at present—one can say nothing stronger.

The volume contains 745 pages and 89 plates, the latter rather coarse line or half-tone drawings, many of which would have been better in the text and considerably reduced. The amount of information in the book is prodigious, and we strongly commend it to all medical officers in parts of the world where libraries do not exist, and who want a plan of the construction of the various flies that are of importance in connection with disease. It includes not only flies, but bugs, lice, fleas, ticks, mites, tongue-worms, and water-fleas. The systematic part whereby species will be recognised will soon be useless, as the fauna of no part of the world is so well known that new species will not be found, at once rendering this section misleading; the rest will remain as an extremely valuable summary of a very complex subject, of permanent value as a reference laboratory manual, and one that is a notable advance in this subject. The authors write clearly, and obviously describe what they themselves do: their methods are simple and efficient, and of the greatest assistance to those placed in similar circumstances who have not their experience.

In addition to a minute account of the anatomy, the authors give detailed descriptions of the methods of keeping in captivity the many blood-sucking insects with which they deal. This is perhaps the most valuable part of the book, and one that will be of the greatest use to those who wish to breed and study insects they may think are connected with the transmission of disease. The volume will not assist those who wish to study the living insect in the field: it is a laboratory manual in which only those things are dealt with which concern the laboratory student; it does not deal with prevention or check, as its title may lead some to expect.

We congratulate the authors on a very remarkable work, the more so when one knows the adverse conditions of climate with which they had to contend. It is an illuminating commentary also on the possibilities there are for men keen on investigation to go to India, for nowhere else perhaps could men get the time, the material assistance, and the inducements to perform such work as is possible under the enlightened policy (in these times) of the Indian Government.

When a fresh edition is required we hope the authors will condense the descriptions of species or omit them in favour of keys, leave out matter such as that on page 177, and reproduce their illustrations in a less coarsely diagrammatic manner.

H. M. L.

GEOGRAPHY.

Northumberland.—By S. RENNIE HASLEHURST, M.Sc., F.G.S. 181 pages. 63 figures. 7 maps. 7 diagrams. 7½-in. × 5-in.

(The Cambridge University Press. Price 1/6.)

The little volume dealing with Northumberland in the series of Cambridge County Geographies is quite as interesting as its fellows. The chapter on Natural History calls for particular attention, for Northumberland includes the Farne Islands, with its wonderful wealth of bird life; while in Newcastle is the celebrated Hancock Museum, and there have been plenty of naturalists to work out the flora and fauna of the county. There is a full account of the Roman remains under the heading of Antiquities, and on the roll of honour we find the name of John Blenkinsop and George Stephenson; while, besides the brothers Hancock, whose museum has been mentioned, there are Joshua Alder and Thomas Belt, the author of "The Naturalist in Nicaragua."

W. M. W.

HORTICULTURE.

The Horticultural Record.—Compiled by REGINALD CORY. 500 pages. 96 plates. 71 figures. 12-in. × 9¼-in.

(J. & A. Churchill. Price 42/- net.)

The International Horticultural Exhibition of 1912 was such a triumph that this present sumptuous volume forms a fitting permanent record of the occasion. It is more, however, for it gives an account of the progress which has been made in the horticultural art since the first international exhibition, held in the year 1866. Many of the coloured plates, taken from photographs by the three-colour process, are exceedingly beautiful, and when one remembers that the exposures had to be made against time, as it were, in adverse circumstances very often, and in tents where there was insufficient light, we think that those concerned are very greatly to be congratulated. As may be imagined, there are full details as to the awards made; but the book also includes reports on horticultural education, on the conference held upon this important subject as well as much information with regard to legislation in connection with plant diseases. Every serious student of horticulture should add this book to his library, in order to take pleasure from turning over its pages, and to gain profit by using it as a work or reference.

W. M. W.

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PHYSICAL GEOGRAPHY.

The Improvement of Rivers (Parts I and II). — By B. F. THOMAS and D. A. WATT. 369 pages. 76 plates. 249 figures. 11¼-in.×9¼-in.

(Chapman & Hall. Price 31/6, 2 vols.)

The proper use of rivers is a problem that this country has hardly taken the trouble to solve, partly, of course, because the most of our English rivers are of comparatively small importance, and partly because the law relating to ownership and responsibility is in a very unsatisfactory condition. In the United States of America, where the rivers are all important to the country's welfare, conditions are different, and it is not surprising to find that "The Improvement of Rivers," by Messrs B. F. Thomas and D. A. Watt, has reached a second edition. It is issued in two bulky volumes by John Wiley & Sons of New York and Chapman and Hall in London. The work has been done well and in comprehensive fashion, starting with a study of the characteristics of rivers and passing to all the work by which man can guide and regulate the flow of water to his best advantage. The cost of dredging has been studied the world over; the protection of banks and the questions relating to storage reservoirs will be found full of interest to those who have any interest in river control, and find themselves face to face with the need for accurate modern information. But it is the study of canalisation that bears most directly upon this country's interests at a time when the question of reviving the use of canals that have been allowed to fall into disuse is being considered seriously. It may be said that no problem of construction or maintenance has been overlooked, and in search of material the authors have cast a very wide net, and have secured a remarkable series of sketches and diagrams. One would like to see a greatly condensed and inexpensive edition of this work published in England: it might go far to remind local authorities of the existence in our midst of a source of revenue and convenience that is well-nigh overlooked to-day. We have very few rivers that may be said to be worth a tithe of the expenditure involved by most of the operations that Messrs. Thomas and Watt describe, but we have scores of small rivers that seem to serve no more useful purpose to-day than to make the surrounding country impassable upon occasion. Perhaps if our lesser rivers had a commercial importance they would receive some attention; at present their neglect is little less than a scandal. It may be remarked that the authors, in writing of English waterways, limit their brief remarks to the river Thames and the Manchester Ship Canal.

S. L. B.

SPECTROSCOPY.

Index of Spectra, Appendix V.—By W. MARSHALL WATTS, D.Sc.(Lond.), B.Sc. (Vict.), late Senior Science Master in the Giggleswick School. 92 pages. 8½-in.×5½-in.

(W. Wesley & Son. Price 12/6. Post free.)

One of those pieces of work like Bradley's and Groombridge's list of the places of the stars that are the foundation-stones on which cosmology is built.

It gives on one uniform standard scale the work of many investigations from all countries, and also references to a large number of books.

The lines of the spectra tabulated are those of Air, Aldebaranium, Aluminium, Alumina, Ammonia, Antimony, Argon, Arsenic, Barium, Beryllium, Bismuth, Boron, Bromine, Cadmium, Caesium, Calcium, Carbon, Cassiopeium, Cerium, Chlorine.

The surprising accuracy of modern work is well exhibited. In cases where sometimes half a dozen or more observers' results are classified scarcely any cases occur where the results are more than a single A.U. out.

Some of the work has not been previously published. A fairly successful attempt has been made to associate the lines with formulae, and, although some of the formulae may be but empirical, yet they show law and order is at work. Especially fine is the regularity of the bands of cyanogen.

The work of some fifty observers and experimentalists is classified. One cannot help noticing the industry of Professor Fowler: it is not long ago that he solved the problem of Secchi's third-type stars that for so many years were enigmas to astronomy, and showed them to be due to titanium oxide. Quite recently he showed clearly the absolute coincidence of the spectra of a comet with that of carbonic oxide. A large amount of both his published and unpublished work is contained in this index. Amongst the many names one sees a good deal of the work of such well-known names as Deslandres, J. J. Thomson, Rayleigh, Duffield, Eder, and Valenta.

A. W. B.

NOTICES.

NEW SCIENTIFIC BOOKS.—In Messrs. Macmillan's new list of forthcoming books for April there is a number dealing with science and education which are of interest to our readers.

BLACK'S "MEDICAL DICTIONARY."—The "Medical Dictionary," edited by Dr. Comrie, is a standard work for the layman, and a new edition of it is promised in which many improvements will be made.

GUIDE DEMONSTRATORS.—The progress of the movement in favour of the appointment of official guides at Government institutions is indicated by the announcement that there is now one on the staff of the National Gallery of British Art, Millbank. Applications for special guidance should be sent to the Official Guide, care of the Keeper.

THE PEOPLE'S BOOKS.—Messrs. Jack announce another six volumes in their "People's Books" Series. These are as follows: "Bacteriology," by W. E. Carnegie Dickson, M.D.; "Anglo-Catholicism," by A. E. Manning-Foster; "Robert Louis Stevenson," by Rosaline Masson; "Canada," by Ford Fairford; "Tolstoy," by L. Winstanley, M.A.; and "Greek Literature," by H. J. W. Tillyard, M.A.

INTERNATIONAL CONGRESS OF TROPICAL AGRICULTURE.—The Third International Congress of Tropical Agriculture will be held in London at the Imperial Institute from June 23rd to June 30th, 1914. A copy of the members' circular which has reached us gives lists of the papers which have been promised, and of the associations and countries which are sending delegates or representatives. All particulars can be obtained from the Organising Secretaries at the Imperial Institute, London, S.W.

SECOND-HAND INSTRUMENTS.—Mr. C. Baker has favoured us with a copy of his classified list of second-hand instruments, which will be sent post free from 244, High Holborn, to any applicant. The list contains descriptions of nearly two thousand pieces of scientific apparatus, and includes a very fine selection of modern microscopes, objectives, telescopes, and spectroscopes, from which anyone who has need of such apparatus can hardly fail to be able to make a choice.

HULL MUSEUM PUBLICATIONS.—The quarterly list of additions for the Hull Museum edited by Mr. Thomas Sheppard has reached us, and, as usual, contains matters of considerable interest to the student of antiquities, as well as a paper by the Editor on "The Chalk Fossils in Hull Museum." We note an account of an experiment, recently tried by the Curator, of personally conducting parties round

the Museum. Those who know Mr. Sheppard will not be surprised to hear that his efforts have been very successful, and that the experiment will be continued.

CAB SIGNALS AND TRAIN STOPS.—Mr. William H. Dammond is continuing, in *The Railway News*, his articles on direct signalling to the drivers of trains. He says that unless the cab system gives three distinctive results—" clear," " run slow," and " stop "—it is not worthy of adoption or test. Important as it is to send a clear signal for any given train, it is exceedingly more important not to give that signal to another train. Mr. Dammond discusses three general classes of signalling before the public to-day. They are all electrical, and are as follows: Wireless, contact bar, and the ramp type.

MEDICAL AND SCIENTIFIC CIRCULATING LIBRARY.—We have received from Mr. H. K. Lewis the second supplement to the catalogue of his Medical and Scientific Circulating Library, which, apart from the index and contents, occupies ninety-six pages. The original catalogue, which was revised at the end of the year 1907, together with the first supplement, may be obtained by subscribers for 2/-. For the benefit of those students who are wishful to read books that they do not care to keep we may mention that the address of Lewis's Library is 136, Gower Street, London, W.C.

PHOTO-MICROGRAPHY.—Those who are anxious to become familiar with the art of photo-micrography should make a point of attending the six practical demonstrations which Mr. Edgar Senior will give at the South-Western Polytechnic Institute, Chelsea, on Monday evenings, beginning on May 4th, 1914. At the demonstrations special attention will be given to the Photographing of Etched Surfaces of Metals and Alloys (Metallography), but the course will also be arranged to suit the requirements of students of Geology, Botany, or Zoölogy, and of those wishing to use their own microscopes to obtain photographic records of objects.

THE PRINTING EXHIBITION.—The Printing and Allied Trades Exhibition, to be opened at the Royal Agricultural Hall by the Lord Mayor of London on May 13th, promises to be of exceptional interest. It will be the largest and most representative Exhibition of its kind ever held in any part of the world, every available space in the Great Hall, the Gilbey Hall, King Edward's Hall, and the Galleries being occupied with exhibits strictly appertaining to the graphic arts; new machinery and appliances will be shown, alike interesting to the expert and the general public, in addition to a very fine display of specimens of printing by all processes, including photogravure. The Exhibition will remain open until May 30th.

ADDITIONS TO THE MENAGERIE OF THE ZOÖLOGICAL SOCIETY.—In March, the registered additions to the Zoological Society's Menagerie were one hundred and nine in number. The following may be specially mentioned: Two Grévy's Zebras (*Equus grévyi*), ♀ ♀, from Abyssinia, purchased on March 2nd; three Indian Antelopes (*Antilope cervicapra*), presented by H.M. the King on March 2nd; one Eland (*Taurotragus oryx*), ♀, born in the Menagerie on March 3rd; one Ibean Potto (*Perodicticus ibeanus*), new to the Collection, deposited March 2nd; two Blue-cheeked Amazon Parrots (*Chrysotis versicolor*), from St. Lucia, presented by E. J. Cameron, C.M.G., on March 2nd.

HAMPSTEAD SCIENTIFIC SOCIETY.—The excellent work which the Hampstead Scientific Society is doing is recorded once more in the report for the year 1913, which has just been issued. The fact that the South Eastern Union of Scientific Societies held its congress at Hampstead last summer made the past year memorable, and the book entitled " Hampstead Heath, its Geology and Natural History," prepared by members of the Society, will be a lasting record of the Society's energy. The report contains abstracts of papers read before the Society as a whole and before the sections. It is hardly necessary to remind our readers of the Astronomical Observatory maintained by the Society, or the Meteorological Observations which are regularly made there.

MR. MURRAY'S QUARTERLY LIST.—Among the forthcoming works which will be published by Mr. Murray, as announced in his quarterly list, are the following, which will be of interest to our readers:—" Life and Human Nature," by Sir Bampfylde Fuller, K.C.S.I. (this work is an attempt to construct a natural history—or science—of human nature by tracing behaviour of mind or body to impulses which actuate, more or less definitely, all living creatures, and may be regarded as life's manifestations of itself); " Concerning Animals," by E. H. Aitken; " Nature and Nurture in Mental Development," by Dr. F. W. Mott (this book is an expansion of the Chadwick Public Trust Lectures of 1913); and " Researches into Induced Cell-Reproduction in Amoebae," by John Westray Cropper, M.B., M.Sc.

THE UNIVERSITY OF LONDON, UNIVERSITY COLLEGE.—We notice, in the list of special arrangements for May, the following items, which are of interest to our readers: Monday, May 4th, at 10 a.m., " Carbon Assimilation and Respiration," first of a course for botany students, by Dr. Sarah M. Baker; Monday, May 4th, at 3 p.m., " Advanced General Psychology," first of an advanced course, by Dr. Aveling; Tuesday, May 5th, at 5 p.m., " The Ethnology and Pathology of the Ancient Egyptians," first of a course of four public lectures, by Dr. D. E. Derry; Tuesday, May 5th, at 6 p.m., " Computing, and some Mechanical Aids to Calculation," first of a course of six lectures, by Mr. H. E. Soper; Thursday, May 21st, at 2.30 p.m., " Recent Discoveries in Egypt," public lecture introductory to a course, by Professor Flinders Petrie.

THE THEORY OF THE THIRD BODY.—The London Astronomical Society, as a result of a motion proposed by Mr. J. H. Worthington, M.A., F.R.A.S., has issued a statement regretting the failure of official observatories to use Professor Bickerton's generalisation—the " Impact Theory of Cosmic Evolution "—as a working hypothesis, and saying that, because this efficient correlation is not taught in our seats of learning, scientific progress has been seriously retarded. If the theory of the third body be wrong, it is the duty of the guardians of scientific knowledge to point out its fundamental errors before it is generally accepted. If no basic error can be found, then its proven capacity as a working hypothesis should justify its being taught and used. All communications to be addressed to the Secretary of the London Astronomical Society, 18, Pembridge Mansions, Moscow Road, Hyde Park, W.

THE BINOCULAR MICROSCOPE.—We have received from Mr. Leitz a copy of a paper by Dr. Jentzsch on the subject of the binocular microscope, which is reprinted from *The Journal of the Royal Microscopical Society*. In it the whole subject of binocular microscopes is reviewed, and special attention given to the new type introduced by Mr. Leitz. This is the first successful binocular instrument made for use with all ordinary objectives and eyepieces, including the high powers. Mr. Leitz points out that his new microscope is capable of being used for all purposes to which the binocular is put, and with equal results. Another most important feature and advantage of the instrument is that the research worker can use his eyes for very much longer without strain, and it is likely that by the use of the new binocular many microscopists who would otherwise have to leave off using their instruments will be able to continue their researches.

THE ROYAL INSTITUTION.—At a meeting of the members of the Royal Institution, held on the afternoon of April 6th, the Duke of Northumberland (President) announced that the septennial award under the Acton Endowment had this year been made to Professor C. S. Sherrington,

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Wayneflete Professor of Physiology in the University of Oxford, for his important work entitled "The Integrative Action of the Nervous System," being a synopsis of his elaborate paper published in the Philosophical Transactions of the Royal Society on Experiments in Examination of the Peripheral Distribution of the Fibres of the Posterior Roots of some Spinal Nerves. Previous Actonian awards have been made to Sir George Stokes, Miss Agnes M. Clerke, Sir William and Lady Huggins, and Madame Curie, for achievements in the field of physical science. Professor Sherrington is the first investigator in Experimental Biology to receive this distinction for the third of a century.

A DEFENCE OF ADVERTISING.—A book of equal interest to the business man and social student will shortly be issued by *The Review of Reviews*. Its title is "Advertising and Progress," and its authors are Mr. E. S. Hole, who was intimately associated with the late W. T. Stead, and Mr. John Hart. It is the object of the book to demonstrate that the social service rendered by advertising immeasurably exceeds its cost. It goes on to prove that, far from being an extra charge on the consumer, it enables the public to effect hitherto impossible economies. It contends that the charge of advertising falls on the obsolete and obsolescent costly selling methods which it displaces. The book is provided with an array of statistics, diagrams, facts, and arguments, but the authors have written from a standpoint which will retain for them the interest of the general reader. It is a careful and reasoned defence of advertising which will evoke much discussion among students and critics of that much maligned but rapidly developing institution.

THE BRITISH GEOMETRIDAE.—For the last six years Mr. F. N. Pierce and the Rev. C. R. N. Burrows have been studying the genitalia of the British Geometridae, and the plates and letterpress of their book on the subject are now in the hands of the printers. The work is illustrated by 1570 outline drawings of the genital parts of practically every recognised British species. The writers have attempted a classification based entirely on the genitalia, which, in many cases, helps to confirm the latest systems where other structures have been considered. Nothing of the kind has ever been attempted with the British Geometridae before, and the exceeding beauty of the structures will come as a surprise to many who only know Lepidoptera by their wing-markings.

We are pleased to echo the appeal of the authors for a large number of subscribers. For copies ordered in advance seven shillings and sixpence will be charged. The published price is ten shillings net. Orders should be sent to Mr. Pierce, "The Elms," Dingle, Liverpool.

ROTHAMSTED EXPERIMENTAL STATION.—The annual report for 1913 of the Lawes Agricultural Trust has been issued, and from it we learn that the Lawes and Gilbert Centenary Fund is not yet closed, there still being £950 to raise before the new laboratories can be built. The Centenary Fund was established for the purpose of collecting £6000 whereby to qualify for a Development Grant of £6000, and thus obtain a sum sufficient to erect and equip a laboratory at Rothamsted to replace the old laboratory, which, after nearly sixty years of use, is now too small and unsuitable for modern requirements. The fund has been generously supported, subscriptions, large and small, having come in from Great Britain and Ireland, from France, Belgium, Holland, Germany, Spain, Canada—where the Federal Government gave five hundred dollars—United States, India, and Australia. The Committee is particularly anxious to clear off this last sum, and to begin building operations at an early date. Subscriptions should be sent to the Secretary, Rothamsted Experimental Station, Harpenden, Herts.

THE INSTITUTE OF METALS: MAY LECTURE. Professor E. Heyn, of Berlin, will this year deliver the annual May Lecture before the Institute of Metals. Professor Heyn, who has made a life-long study of the subject, has given the title of his discourse as "Internal Strains in Cold Wrought Metals, and some Troubles caused thereby." The Institute of Metals is fortunate in its May Lecturers and in the natural sequence of the subjects dealt with at these lectures. Thus, the last May Lecture, by Sir J. Alfred Ewing, K.C.B., F.R.S., was on the subject of "The Inner Structure of Simple Metals," and previously Dr. G. T. Beilby, F.R.S., had lectured on an allied subject, "The Hard and Soft States in Metals." Professor Heyn's discourse will be given in the building of the Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W., under the chairmanship of Admiral Sir Henry Oram, K.C.B., F.R.S., the President of the Institute of Metals, on Tuesday, May 12th, at 8.30 p.m. The Secretary of the Institute, Mr. G. Shaw Scott, M.Sc., of Caxton House, Westminster, S.W., will be glad to forward tickets to any readers who may desire to be present at the May Lecture.

ANTHROPOID APES IN CAPTIVITY.—At the meeting of the Zoölogical Society of London, held on April 17th, Dr. Mitchell exhibited the photograph of a female Orang-utan (*Simia satyrus*), kindly sent to him by Mr. W. H. D. Le Souëf, the Director of the Zoölogical Gardens at Melbourne. According to the statement of Mr. Le Souëf, this Ape had lived in the Gardens at Melbourne for twelve years in an open-air enclosure attached to a shelter without any artificial heat. Dr. Mitchell said that Orangs were notoriously difficult to keep alive in captivity, and even in Singapore they seldom lived for two years after capture. Mr. Le Souëf's example was certainly extremely interesting. In the Society's own Gardens, a fine male Orang, obtained on September 7th, 1905, was still alive, and it was reported to have been in captivity for eight years before it came to London, so that it was still older than the Melbourne example, and had shown the cheek-plates for the last two years. Chimpanzees were less delicate, but the average duration was not good. The Chimpanzee known as "Mickie," which had been purchased by the Society on April 6th, 1898, was still living, and certainly was the Anthropoid Ape known to have lived longest in captivity. The almost universal experience with Gorillas was that they lived only a few weeks after reaching Europe, and, in consequence of this high mortality, the Secretary had for some years declined to encourage importers by refusing to buy. In one Continental collection, however, a Gorilla had lived for several years.

THE ALCHEMICAL SOCIETY.—The twelfth general meeting of The Alchemical Society was held on April 17th. The chair was occupied by Mr. Arthur Edward Waite, one of the Vice-Presidents of the Society, whose many alchemical translations and other works are well known, and a very suggestive paper, entitled "Some Reflections on 'Basil Valentine,'" was read by Mr. Philip Sinclair Wellby, M.A. (Cantab). Mr. Wellby called attention to the excellent literary style of "Valentine's" and other alchemical writings—the fine spiritual fervour which suffused them. He maintained that Alchemy was essentially a spiritual process taking place in the soul of man whereby he might become perfected, and capable of controlling the forces of Nature in ways not at present known to science. He supported this bold thesis by quotations from the writings of several modern philosophical thinkers concerning the relations between the worlds of spirit and matter. In the animated discussion which followed Mr. H. Stanley Redgrove, B.Sc. (Lond.), the Acting President of the Society, put forward the counter-thesis that the alchemists were essentially concerned with chemical processes, which they attempted to explain by means of doctrines drawn from the domains of theology, this origin for their theories and speculations making a translation of them into theological terms possible. The full text of the lecture, and a report of the discussion, appears in *The Journal of the Alchemical Society* for April, published by Mr. H. K. Lewis, of 136, Gower Street, W.C., at 2/- net.

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